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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an asynchronous transfer mode (ATM) communication system.

In recent years, the spread of data communications has led to the use of public lines not only for conventional voice communications but also transfer of important data. Future communication networks, therefore, have to be able to transfer and exchange data with a higher quality. As a communication service network able to handle not only 64 Kb/s voice communications and low speed data, but also 150 Mb/s high speed data for moving images such as for television and high definition television images, attention is now being drawn by broadband integrated service digital networks (B-ISDN). These are now reaching the commercialization stage and are being standardized as to their interfaces. In a B-ISDN, unlike the conventional exchange method, use is made of ATM so as to enable equal handling of voice communications, low speed data, moving images, and other information of different speeds. That is, in an ATM switching network, information with different bandwidths are transferred and exchanged held in units of certain lengths called "cells", for the purpose of differentiation from conventional package communication.

2. Description of the Related Art

Such ATM includes variable bit rate (VBR) communication wherein cells (units of transfer of information in ATM) are produced and transferred each time information for communication is produced and constant bit rate (CBR) communication wherein cells are transferred periodically regardless of the existence of information as in the conventional communication systems.

An explanation will be trade later, referring to the figures, of the concept of VBR communication, the concept of CBR communication, and the processing sequences, but here note that in the conventional processing sequence, when the communication bandwidth requested by a terminal equipment at the time of a call setup is larger than the allocable bandwidth of the ATM network, that communication cannot be received and the call is disconnected.

Therefore, communication cannot be performed until the allocable bandwidth at the ATM switching network side satisfies the requested bandwidth and the terminal equipment must repeatedly originate calls until it is allocable. That operation is not only forced on the terminal equipment side, but also results in meaningless processing performed on the ATM switching network side.

For the terminal equipment, there is the problem that when communication is not possible at the requested bandwidth, even if communication is desired at a lower communication quality for a while, that communication is not allowed.

Still further, in the state where communication has begun between two pieces of terminal equipment for which communication is allowed, when desiring to change the communication bandwidth due to a change in the traffic at the ATM switching network side, that change is not allowed and therefore there was the problem that efficient use of the communication lines and other resources on the AT switching network side was not possible.

IEEE International Conference on Communications, "World Prosperity through Communications", 11th to 14th June 1989, Boston, MA. vol. 2, pages 713 - 717, IEEE; K. Nakamaki et al.: "Traffic control for ATM networks", Paragraph 4.2 - paragraph 5 shows features corresponding to those of the preamble of claim 1, but does not disclose sending an allowable bandwidth.

EP-A-0 351 818 shows an ATM switching system including a flow monitoring circuit 205, comprising an illegal cell processing circuit 508. Again there is no notifying of allowable bandwidth.

SUMMARY OF THE INVENTION

Accordingly, an object of the present invention is to provide an ATM communication system and ATM communication method in which the above problems can be resolved and the resources of the ATM switching network can be utilized efficiently at a constantly high efficiency by all the terminal equipment.

According to the present invention, there is provided a system as set out in claim 1. Other aspects of the invention are set out in claims 18 and 20. Preferred features are set out in dependent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

The above object and features of the present invention will be more apparent from the following description of the preferred embodiments with reference to the accompanying drawings, wherein:

Fig. 1 is a view illustrating the general constitution of an AT communication system;
Fig. 2A is a view of the concept of CBR communication;
Fig. 2B is a view of the concept of VBR communication;
Fig. 3 is a view of the processing sequence of a conventional call setup;
Fig. 4 is a view of the sequence emphasizing the defects in the conventional call setup processing;
Fig. 5 is a view simply showing the control sequence (during call setup) under the present invention;
Fig. 6 is a view simply showing the control sequence (in-call) under the present invention;
Fig. 7 is a view showing the basic constitution of a system based on the present invention;
Fig. 8A, Fig. 8B, and Fig. 8C are view showing the basic constitution of the system based on the present invention based on the state where two pieces of terminal equipment are further incorporated for mutual communication;
Fig. 9 is a view of an example of the architecture of a system according to the present invention;
Fig. 10 is a view of the transfer of bandwidth information in the system shown in Figs. 8A, 8B, and 8C;
Fig. 11 is a view of the constitution of an embodiment of a terminal equipment;
Fig. 12 is a view of the constitution of an embodiment of an ATM exchange;
Fig. 13A and Fig. 13B are views showing the processing flow during call setup of an originating terminal equipment;
Fig. 14A and Fig. 14B are views showing the processing flow during call setup of a ATM switching network;
Fig. 15A and Fig. 15B are views showing the processing flow during call setup of a terminating terminal equipment;
Fig. 16A (16A-1, 16A-2), Fig. 16B, and Fig. 16C are processing flow charts for changing the state of bandwidth during communication;
Fig. 17 is a view of an example of a processing sequence executed in the system of the present invention;
Fig. 18 is a view showing an example of the system architecture of the present invention;
Fig. 19 is a view showing the specific concept based on the system architecture of Fig. 18;
Fig. 20 is a view of the concept of the ATM exchange;
Fig. 21A, Fig. 21B, and Fig. 21C are views showing examples of realization of the speech path circuits in the ATM exchange;
Fig. 22 is a view showing an example of a traffic monitor means;
Fig. 23 is a view showing somewhat more specifically the upstream side of the communication line layer;
Fig. 24 is a view showing somewhat more specifically the downstream side of the communication line layer;
Fig. 25 is a view showing somewhat more specifically the traffic control center;
Fig. 26A is a view showing schematically the operation of an analyzing means in a central processing unit;
Fig. 26B is a view showing schematically the operation of an optimum control means in the central processing unit;
Fig. 27 is a view showing an ATM exchange operating receiving the optimum traffic control command; and
Fig. 28 is a view showing a specific example of the traffic control means.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Before describing the embodiments of the present invention, the related art and the disadvantages therein will be described with reference to the related figures.

Figure 1 is a view illustrating the general constitution of an ATM communication system. In the figure, information from a voice terminal equipment 4V, a data terminal equipment 4D, and a picture terminal equipment 4P is composed into cells and then multiplexed by a multiplexer 5'. Further, VCI conversion is performed on the cells at the input stage of the ATM exchange 5, then cell exchange is performed. The structure of the cells is shown at the upper part of the figure and consists of an information part and a header part. The header part includes a virtual channel number (VCI).

The cell group output from the ATM exchange 5 is demultiplexed by the demultiplexer 5", then decomposed into the individual information, which is sent to the corresponding terminal equipment of the other side.

Next, an explanation will be made of the general CBR and VBR communication performed in the general ATM communication system shown in Fig, 1.

Figure 2A is a view of the concept of CBR communication, and Fig. 2B is a view of the concept of VBR communication. In the figure, the transmission slots allocated periodically to the subscribers are constituted of a plurality of cells, the overall number of cells being the maximum amount of information which can be transmitted at one time. In the CBR communication of Fig. 2A, 12 cells are always transferred at a time at set intervals as shown by t1 to t4, so the amount of information transmitted per unit time is fixed and the traffic management at the ATM network side can be treated the same as that in the conventional line exchange art.

On the other hand, in the VBR communication of Fig. 2B, the interval at which cells are transferred is irregular due to the principle of communication mentioned above. When the amount of information is large as at t8, a plurality of cells commensurate with the amount of information, for example, 19, are transferred per unit time. Also, if there is no information for a unit of time, nothing is transferred, as shown at t6. Therefore, the bandwidth of the transmitted information is not constant even during a call, but can handle fluctuations of, for example, a maximum value of 150 Mb/s

and a minimum value of 30 Mb/s and therefore can efficiently accommodate moving picture information etc. where the amount of information communicated fluctuates tremendously. Further, multiplexing is performed without distinction as to line data and packet data in the cell units, so different data can be transferred flexibly and efficient use may be made of the transmission line, making this system promising for future communication systems. The terminal equipment makes standby restrictions for when there is a large amount of information to be transmitted and performs processing for thinning out processing data of coding circuits performing the signal processing in the case of picture data.

Figure 3 is a view of the processing sequence of a conventional call setup. In general, the terminal equipment 4-1 and 4-2 used in VBR communication can recognize the available bandwidth in advance according to the content of the transmission and notifies the ATM switching network of the information of the bandwidth to be used for the call setup (maximum value, mean value, etc.) As opposed to this, the ATM switching network obtains a grasp of the current state of traffic and judges if the bandwidth requested by the terminal equipment can be allowed. The ATM switching network handles input information from various types of terminal equipment and lines, so when the bandwidth requested by a certain terminal equipment exceeds the allocable bandwidth, judges that communication is not possible (NG) and notifies the terminal equipment 4-1 making the request that communication is prohibited ([2]).

Receiving this, the terminal equipment 4-1 notifies the network of the information of the bandwidth to be used (maximum value, mean value, etc.) once again after a certain period ([3]).

When the requested bandwidth is within the allocable bandwidth of the network, the network judges that communication is possible (OK) and sends a call setup (SETUP) message to the terminal equipment 4-2 of the other party ([4]).

The terminal equipment 4-2 judges whether to receive this communication and if in a state to receive it, sends a connection (CONN) message to the terminal equipment 4-1 ([5] and [6]). If it cannot receive it, it sends a disconnection (DISC) message.

The above routine is used for connection of the line and communication.

Figure 4 is a view of the sequence emphasizing the defects in the conventional call setup processing. It shows in a simple manner the causes behind the problems mentioned earlier. That is, in the figure, if the bandwidth requested by the terminal equipment is larger than the allocable bandwidth in the ATM network, the call is immediately disconnected. The terminal equipment retries after a while and succeeds in connection with the ATM switching network when the allocable bandwidth is larger than the requested bandwidth.

Next, an explanation will be made of the present invention, which can solve the above problems in the conventional art. First, the processing sequence of the present invention will be simply shown compared with the above Fig. 3.

Figure 5 is a view simply showing the control sequence (during call setup) under the present invention, and Fig. 6 is a view simply showing the control sequence (in-call) under the present invention. The point in Fig. 5 is that when the communication bandwidth requested by the terminal equipment is larger than the allocable bandwidth of the ATM switching network, the requested communication bandwidth is reduced to the allocable bandwidth and communication then started.

Further, the point in Fig. 6 is that during call setup, even if the terminal equipment has started communication at a reduced communication bandwidth than originally requested, if the allocable bandwidth of the ATM switching network subsequently increases during the call, the communication can be continued while increasing the bandwidth to the one requested.

Figure 7 is a view showing the basic constitution of a system based on the present invention. The ATM switching network communication system 1 of the present invention includes an ATM switching network 2 which includes a plurality of ATM exchanges 5 and controls exchanges among a plurality of terminal equipment 4 and a management apparatus 3 which manages the traffic in the ATM switching network 2; the ATM switching network 2 includes a notifying means 6 which notifies the terminal equipment 4 of the allocable bandwidth δ which can be used in accordance with the amount of traffic in the ATM switching network. When the notified allocable bandwidth is a bandwidth which can be used for their communication, the terminal equipment 4 start the communication in the range of that bandwidth.

The ATM switching network 2 includes a traffic monitoring means 7 which monitors the amount of traffic in the ATM switching network.

The management apparatus 3 includes an analyzing means 31 which analyzes the allocable bandwidth which can be given to the terminal equipment 4 in accordance with the amount of traffic.

The terminal equipment 4 include judgement means 41 which judge whether the allocable bandwidth δ notified from the ATM switching network 2 is a bandwidth of a size allowable for their own communication.

The terminal equipment 4 include request means 42 which request to the ATM switching network 2 the communication bandwidth α required for their own communication.

The ATM switching network 2 includes memory means 8 which store the communication bandwidth α requested by the terminal equipment and required for the communication of the terminal equipment 4. Further, it includes a bandwidth changing means 10 which changes the bandwidth to a communication bandwidth stored in the memory means 8 when the allocable bandwidth δ expands to larger than that communication bandwidth during a call of the terminal equipment 4.

Figure 8A, Fig. 8B, and Fig. 8C are views showing the basic constitution of the system based on the present invention based on the state where two pieces of terminal equipment are further incorporated for mutual communication. In the figures, the ATM communication system 1 is provided with an ATM switching network 2 which includes a plurality of ATM exchanges 5 and controls exchanges among a plurality of terminal equipment 4 and a management apparatus 3 which manages the traffic in the ATM switching network 2.

A first terminal equipment 4-1 and a second terminal equipment 4-2 which can communicate with each other have included in them a first request means 42-1 and a second request means 42-2 which request a first communication bandwidth α a and second communication bandwidth β which they require to the ATM switching network side.

The ATM switching network 2 includes a traffic monitoring means 7 which monitors the amount of traffic in the ATM switching network. The management apparatus 3 includes an analyzing means 31 which analyzes the allocable bandwidth δ which can be given to the first and second terminal equipment 4-1 and 4-2 in accordance with the amount of traffic from the traffic monitoring means 7.

The first and second terminal equipment 4-1 and 4-2 respectively send out the first and second communication bandwidths α and β to the ATM switching network 2 from the first and second request means 42-1 and 42-2.

The analyzing means 31 in the management apparatus 3 decides on a common available bandwidth δ for the first and second terminal equipment 4-1 and 4-2 based on the first and second communication bandwidths α and β received through the ATM switching network 2 and the amount of traffic monitored by the traffic monitoring means 7. The available bandwidth decided on is notified to the first and second terminal equipment 4-1 and 4-2 through a notifying means 6 provided in the ATM switching network 2.

The first and second communication bandwidths α and β are the maximum bandwidths expected to be necessary for the communication by the first and second terminal equipment 4-1 and 4-2. Alternatively, the first and second communication bandwidths α and β are the mean values of the bandwidths expected to be necessary for the communication by the first and second terminal equipment 4-1 and 4-2.

The ATM switching network 2 includes a memory means 8 which stores the first and second communication bandwidths α and β requested from the first and second terminal equipment 4-1 and 4-2 at the start of communication between the terminal equipment. Further, the analyzing means 31 includes a bandwidth changing means 10 which notifies the first and second terminal equipment 4-1 and 4-2 of a changed bandwidth comprising the current first and second communication bandwidths α and β expanded to a new allocable bandwidth when judging during communication between the first and second terminal equipment 4-1 and 4-2 that the allocable bandwidth δ has expanded to the first and second communication bandwidths α and β stored in the memory means 8.

The first and second terminal equipment 4-1 and 4-2 include a first memory means 43-1 and a second memory means 43-2 which store respectively the first and second communication bandwidth α and β requested to the ATM switching network 2 by them at the time of the start of communication.

The first and second terminal equipment 4-1 and 4-2 include a first decision means 44-1 and a second decision means 44-2 which decide whether to start communication by the available bandwidth commanded from the ATM switching network 2.

The traffic monitoring means 7 is provided in the ATM exchanges 5 of the ATM switching network 2.

The management apparatus 3 is provided with an optimal control means 32 which produces optimal traffic control information based on the results of analysis by the analyzing means 31 and supplies the information to the ATM switching network 2.

A traffic control means 9 which receives the optimal traffic control information supplied from the optimal control means 22 and performs the control of the traffic is provided in the ATM exchange 5.

A bandwidth changing means 10 which notifies the first and second terminal equipment 4-1 and 4-2 that the present available bandwidth allocated for the communication between the two will be changed based on the optimal traffic control information is provided in the ATM exchanges 5.

The traffic control means 9 in the ATM exchanges 5 has a safety factor table unit 91 which sets in advance the safety factor showing the range of allowance of fluctuations in the amount of traffic for each of the communication media (V, D, and P in Fig. 1) which the first and second terminal equipment 4-1 and 4-2 handle and stores the set safety factors as a table; a threshold generating unit 92 which generates a threshold value obtained by multiplying the available bandwidths by the corresponding safety factors for each of the communication media; a comparing unit 93 which compares the amount of traffic obtained by the traffic monitoring means 7 and the threshold value obtained from the threshold generating unit 92; and a cell abandonment indicating unit 94 which sends out a command for abandoning a communication cell between the first and second terminal equipment 4-1 and 4-2 in the ATM exchanges 5 when the result of the comparison by the comparison unit 93 is that the amount of traffic has exceeded the threshold value.

The first and second terminal equipment 4-1 and 4-2 include media classification notifying means 45-1 and 45-2 which notify the classification of the communication media to the traffic control means 5.

Figure 9 is a view of an example of the architecture of a system according to the present invention. Note that throughout the figures, elements of similar structures are indicated by the same reference numerals or symbols. One

of the points of this figure is the provision of the communication line for transfer information on the traffic transferred between the management apparatus 3 and the ATM exchange 2. The construction of Fig. 9 will be explained in more detail later.

The basic operation performed in the ATM communication system in the present invention consists of the following steps:

Step 1

When communication is to be performed between the first terminal equipment 4-1 and the second terminal equipment 4-2, the first communication bandwidth α required for the communication is sent through the first request means 42-1 in the first terminal equipment on the originating side to the ATM switching network 2 at the start of the communication.

Step 2

The ATM switching network 2 side monitors the amount of traffic in the ATM switching network 2, analyzes the bandwidth allocable to the terminal equipment in the ATM switching network 2, and,when receiving the first communication bandwidth α from the originating side first terminal equipment 4-1, sends the received first communication bandwidth α together with the allocable bandwidth δ to the terminating side second terminal equipment 4-2.

Step 3

The second terminal equipment 4-2, when receiving the allocable bandwidth δ and the first communication bandwidth α, sends the second communication bandwidth β which the second terminal equipment 4-2 requests for communication, through the second request means 42-2 in the equipment to the ATM switching network 2 side.

Step 4

The ATM switching network 2 decides on the available bandwidth to be commonly occupied by the first and second terminal equipment 4-1 and 4-2 based on the first and second communication bandwidths (α and β) and the allocable bandwidth δ.

Step 5

The decided on available bandwidth δ is sent from the ATM switching network 2 side to the first and second terminal equipment 4-1 and 4-2.

The above-mentioned basic operation preferably includes the following steps:

Step I

The first and second communication bandwidths (α and β) sent from the first and second terminal equipment 4-1 and 4-2 at the start of the communication are stored at the ATM switching network 2 side.

Step II

The first and second terminal equipment decide by their decision means 44-1 and 44-2 whether the available bandwidth δ decided on and notified by the ATM switching network can be received.

Step III

During the call between the first and second terminal equipment, the ATM switching network side detects if the alloсable bandwidth δ exceeds the stored first and second communication bandwidths (α and β).

Step IV

When it detects that it exceeds the same, the ATM switching network side notifies the first and second terminal equipment side of the stored first and second communication bandwidths (α and β).

Step V

The first and second terminal equipment decide by their respective decision means 44-1 and 44-2 to change the presently used bandwidth.

Figure 10 is a view of the transfer of bandwidth information in the system shown in Figs. 8A, 8B, and 8C. In the figure, 4-1 and 4-2 are broadband (B) ISDN terminal equipment TE able to handle VBR communication and 2 is a B-ISDN ATM switching network

Reference numeral 6 is a notifying means in the B-ISDN which decides on the available bandwidth information γ to be used for the communication from received requested communication bandwidth information α and the allocable bandwidth information δ presently being provided.

Reference numeral 42-1 is a first request means which includes a means for monitoring the amount of the presently used bandwidth in the terminal equipment 4-1.

Reference numeral 44-2 is a decision means which decides on the available bandwidth information (γ) to be used for communication from the received available bandwidth γ and the requested communication bandwidth β of the terminal equipment in question.

Reference numeral 10 is a bandwidth changing means which recognizes the change in the state of the bandwidth in the ATM switching network 2 and sends the changed bandwidth amount to the terminal equipment 4-1 and 4-2.

A notifying means 6 designates and notifies the available bandwidth γ between the originating side terminal equipment (TE) 4-1 and the terminating side terminal equipment (TE) 4-2 based on the communication bandwidth α requested from the originating side terminal equipment (TE) 4-1, the communication bandwidth β requested from the terminating terminal equipment (TE) 4-2, and the allocable bandwidth δ grasped by the ATM switching network 2.

The ATM switching network 2 is provided with a bandwidth changing means 10 which monitors the amount of traffic in communication and notifies a changed bandwidth when the state of the bandwidth changes. When there is a change in the communication bandwidth grasped by the ATM switching network 2 side during a call between the originating terminal equipment (TE) 4-1 and the terminating terminal equipment (TE) 4-2 through the ATM switching network 2, the bandwidth changing means 10 notifies the change of the communication bandwidth to the originating terminal equipment (TE) 4-1 and the terminating terminal equipment (TE) 4-2.

Further, the originating terminal equipment (TE) 4-1 is provided with a request means 42-1 which monitors the presently used bandwidth amount. The originating terminal equipment (TE) 4-1 superposes the maximum value of the bandwidth used as α on the call setup signal by the means 42-1 and sends it to the ATM switching network 2.

Further, the terminating terminal equipment (TE) 4-2 is provided with a decision means 44-2 which decides on the available bandwidth δ to be used for communication from the received allocable bandwidth δ and the communication bandwidth β which that terminal equipment itself requested. When it receives an allocable bandwidth δ from the ATM switching network 2, it decides, by the decision means 44-2, on the available bandwidth γ to be used for communication from the communication bandwidth β which that terminal equipment itself had requested.

In the present invention, at the call setup, the terminal equipment (TE) 4-1 sends out the maximum bandwidth to be used for communication to the ATM switching network 2 as the requested communication bandwidth α. The ATM switching network 2 receives the communication bandwidth α, compares the allocable bandwidth δ which can be presently provided for the communication, and decides on the available bandwidth γ. The other terminal equipment (TE) 4-2 receives the available bandwidth γ, compares it with the communication bandwidth β requested by the terminal equipment itself, and decides on the available bandwidth γ.

Further, even during communication, the ATM switching network 2 sends out the bandwidth change to the two terminal equipment (TE) 4-1 and 4-2 each time there is a change in the bandwidth state. Therefore, it is possible to change the communication bandwidth between the terminal equipment 4-1 and 4-2 commensurate with the changes in the bandwidth at the ATM switching network 2 side.

Figure 11 is a view of the constitution of an embodiment of a terminal equipment. In the figure, a central processing unit (CPU) 40 and a memory (MEM) 420 cooperating with the same form the above-mentioned judging means 41, request means 42, memory means 43, decision means 44, and media classification notifying means 45.

In Fig. 11, the information data from an information generating unit 460 and control information from a D-channel control unit 430 are packed into a packet called a cell by a cell composing/decomposing unit 440 and are sent through an interface unit 450 to the ATM switching network 2. The CPU 410 recognizes the present amount of cell transmission while monitoring the cell composing/decomposing unit 440 at all times, and sends out the communication bandwidths (α and β) requested to the ATM switching network 2 at the time of communication.

Figure 12 is a view of the constitution of an embodiment of an ATM exchange. In the figure, a CPU 510 and a memory 520 which cooperates with the same form the above-mentioned notifying means 6, memory means 8, traffic control means 9, and bandwidth changing means 10.

In general, an ATM switching network (ISDN) includes a large number of the ATM exchanges 5 shown in Fig. 12. In the figure, 540 is a line trunk unit which accommodates lines from the terminal equipment 4, 530 is an ATM exchanging

function unit which multiplexes the cells and outputs them to the destination line, and 550 is a line trunk unit which accommodates connected lines among the exchanges. Reference numeral 3 is the above-mentioned management apparatus, which is linked with an incoming cell number monitoring function unit 71 (corresponding to traffic monitoring means 7).

The communication bandwidth α placed on the call setup message from the terminal equipment 4 is received by the line trunk unit 540. Then, the incoming cell number monitoring function unit 71 which monitors the current amount of traffic at all times sends the requested communication bandwidth α to the management apparatus 3. The management apparatus 3 receives the allocable bandwidth from the incoming cell number monitoring function unit 71 provided for each ATM exchange 5. The cells from the terminal equipment in the communication state are switched by the ATM exchanging function unit 530, multiplexed for every destination line, asynchronously sent through the line trunk unit 550 to the other ATM exchange, and connected to the terminal equipment 4-2 at the other communication party.

Figure 13A and Fig. 13B are views showing the processing flow during call setup of an originating terminal equipment; Fig. 14A and Fig. 14B are views showing the processing flow during call setup of a network 2; and Fig. 15A and Fig. 15B are views showing the processing flow during call setup of a terminating terminal equipment. The # marks in the figures show the inputs and outputs among terminal equipment. Below, an explanation will be made of the flow of processing during call setup.

In Fig. 13A, the originating terminal equipment 4-1, when transmission information is generated, decides whether to perform communication based on VBR communication and by fixed band communication or to perform communication based on VBR communication and by variable band communication (step a). When performing fixed band communication (NO in step a), it sets the requested bandwidth information BW0 to be fixed (step b). Then, it places this in the call setup (SETUP) message and sends it to #1 of the ATM switching network 2 (step c).

When performing variable band communication (YES in step b), it designates a predetermined available bandwidth (for example, the maximum value) as the requested communication bandwidth BW0 (step d) according to the type of the information sent (for example, voice, data, moving picture), places it in the call setup (SETUP) message, and sends it to #1 of the ATM switching network 2 (step e).

In Fig. 14A, the ATM switching network 2, when receiving the call setup (SETUP) message from the originating terminal equipment 4-1 (step a), compares the requested communication bandwidth BW0 with the allocable bandwidth BW1, that is, the bandwidth which the ATM switching network 2 can allocate (step b).

When the requested communication bandwidth BW0 is larger than the allocable bandwidth BW1 and the originating terminal equipment is requesting fixed band communication (NO at step c), communication is not allowed, so a disconnection (DISC) message indicating reception is not possible is returned to #4 of the terminal equipment 4-1 (step d).

When the requested communication bandwidth BW0 is larger than the allocable bandwidth BW1 and the originating terminal equipment is requesting variable band communication (YES at step c), the allocable bandwidth BW1 is placed in the call setup (SETUP) message to the terminal equipment 4-1 of the other communication party and sent out (step e).

On the other hand, when the requested communication bandwidth BW0 is smaller than the allocable bandwidth BW1 and the originating terminal equipment 4-1 is requesting fixed band communication (NO at step f), the request for fixed band communication at the requested communication bandwidth BW0 is sent to the terminal equipment 4-2 of the other communication party (step g).

When the requested communication bandwidth BW0 is smaller than the allocable bandwidth BW1 and the originating terminal equipment 4-1 is requesting variable band communication (YES at step f), the requested communication bandwidth BW0 is made the requested communication bandwidth information and placed in the call setup (SETUP) message to the terminal equipment 4-2 of the other communication party for transmission to the same (step h).

In Fig. 15A and Fig. 15B, the terminating terminal equipment 4-2, when receiving a call setup (SETUP) message from the ATM switching network 2 (step d), decides whether or not to perform variable band communication or to perform fixed band communication (step b).

When both the originating terminal equipment 4-1 and the terminating terminal equipment 4-2 perform variable band communication (YES at step c), a comparison is made between the allocable bandwidth BW0 or BW1 from the ATM switching network 2 and the requested communication bandwidth BW2 of the terminating terminal equipment 4-2 (step d). Then, when the allocable bandwidth BW0 or BW1 is smaller than the requested communication bandwidth BW2 of the terminating terminal equipment (YES at step d), the allocable bandwidth BW0 or BW1 is decided on as the available bandwidth BW3 and a connection (CONN) message containing this BW3 is sent to #3 of the ATM switching network 2 (step e). On the other hand, when the allocable bandwidth BW0 or BW1 is larger than the requested communication bandwidth BW2 of the terminating terminal equipment 4-2 (NO at step d), the requested communication bandwidth BW2 is decided on as the available bandwidth BW3 and a connection (CONN) message containing this BW3 is sent to #3 of the ATM switching network 2 (step f).

When the originating terminal equipment 4-1 performs fixed band communication and the terminating terminal equipment 4-2 performs variable band communication (NO at step C), the allocable bandwidth BW0 and the requested communication bandwidth BW2 are compared (step g). Then, when the allocable bandwidth BW0 is smaller than the

requested communication bandwidth BW2 of the terminating terminal equipment 4-2 (YES at step h), the allocable bandwidth BW0 is decided on as the available bandwidth BW3 and a connection (CONN) message containing this BW3 is sent to #5 of the ATM switching network 2 (step h). On the other hand, when the allocable bandwidth BW0 is larger than the requested communication bandwidth BW2 of the terminating terminal equipment 4-2 (NO at step g), a disconnection (DISC) message showing that reception of fixed band communication is refused, that is, the allocable bandwidth BW0, is sent to #5 of the ATM switching network 2 (step i).

When the originating terminal equipment 4-1 performs variable band communication and the terminating terminal equipment 4-2 performs fixed band communication (YES at step j), the allocable bandwidth BW0 or BW1 and the requested communication bandwidth BW2 are compared (step k). Then, when the allocable bandwidth BW0 or BW1 is smaller than the requested communication bandwidth BW2 of the terminating terminal equipment 4-2 (YES at step k), fixed band communication of the requested communication bandwidth BW2 cannot be received, so a disconnection (DISC) message is sent to #3 of the ATM switching network 2 (step 1). On the other hand, when the allocable bandwidth BW0 or BW1 is larger than the requested communication bandwidth BW2 of the terminating terminal equipment 4-2 (NO at step k), the requested communication bandwidth BW2 is decided on as the available bandwidth BW3 (step m) and a connection (CONN) message containing the BW3 is sent to #3 of the ATM switching network 2.

When both the originating terminal equipment 4-1 and the terminating terminal equipment 4-2 perform fixed band communication (NO at step j), it is judged if the allocable bandwidth BW0 and the requested communication bandwidth BW2 coincide (step n). If equal at this time (YES at step n), the requested communication bandwidth BW0 is decided on as the available bandwidth BW3 (step o) and a connection (CONN) message containing this BW3 is sent to #5 of the ATM switching network 2. On the other hand, if not equal (NO at step n), a disconnection (DISC) message is sent (step p).

In this way, the terminating terminal equipment 4-2 decides on the available bandwidth BW3.

In Fig. 14B, when the originating terminal equipment 4-1 performs variable band communication, if the ATM switching network 2 receives a connection (CONN) message containing the available bandwidth BW3 or a disconnection message (DISC) message from the terminating terminal equipment 4-2, it sends the above message as is to #6 of the originating terminal equipment 4-1 (step j). On the other hand, when the originating terminal equipment 4-1 performs fixed band communication, if the ATM switching network 2 receives from the terminating terminal equipment 4-2 a connection (CONN) message containing the available bandwidth BW3 or a disconnection (DISC) message (step k), it sends the above message as is to #4 of the originating terminal equipment 4-1 (step 1).

In Fig. 13B, if the terminal equipment 4-1 receives a connection (CONN) message or disconnection (DISC) message from the ATM switching network 2 in a variable band communication state (step f), it judges which message has been received (step g).

When receiving a disconnection (DISC) message (YES at step g), it gives up on communication (step h).

When receiving a connection (CONN) message (NO at step g) and when the opposing terminal equipment performs variable band communication (YES at step i), it performs variable band communication by the available bandwidth BW3 (step j). On the other hand, when receiving a connection (CONN) message (NO at step g) and when the opposing terminal equipment is performing fixed band communication (NO at step i), it performs fixed band communication by the available bandwidth BW3 (step k).

If the terminal equipment 4-1 receives connection (CONN) message or disconnection (DISC) message from the ATM switching network 2 in the fixed band communication state (step l), it judges which message has been received (step m).

When receiving a disconnection (DISC) message (YES at step m), it gives up on communication (step n).

When receiving a connection (CONN) message (NO at step m), it performs fixed band communication by the available bandwidth BW3.

The call setup is performed by the above flow of processing.

Figure 16A, Fig. 16B, and Fig. 16C are processing flow charts for changing the state of bandwidth during communication. When, during communication, the bandwidth state BW3 of the ATM switching network 2 changes to the bandwidth state BW4 (step a), the changed bandwidth BW4 is notified to the terminal equipment 4-1 and 4-2 (step b). The terminal equipment 4-1 and 4-2, when receiving notification of the changed bandwidth (step c and d), send to the ATM switching network 2 the changed communication bandwidths BW0' and BW1' which they currently request (steps f and h).

The ATM switching network 2, when receiving the changed communication bandwidth BW0' of the terminal equipment 4-1 and the changed communication bandwidth BW1' of the terminal equipment 4-2 (step h), compares the sizes of the changed communication bandwidths BW0' and BW1' received from the terminal equipment 4-1 and 4-2 (step i).

If the changed communication bandwidth BW0' from the terminal equipment 4-1 is smaller than the changed communication bandwidth BW1' from the terminal equipment 4-2 and is smaller than the changed communication bandwidth BW4 (YES at step j), the changed bandwidth BW0' from the terminal equipment 4-1 is decided on as the changed available bandwidth BW5 (step k) and an information (INFO) message containing this BW5 is sent to the two terminal

equipment 4-1 and 4-2 (step l).

On the other hand, if the changed communication bandwidth BW0' from the terminal equipment 4-1 is smaller than the changed communication bandwidth BW1' from the terminal equipment 4-2 and is larger than the changed communication bandwidth BW4 (NO at step j), the changed bandwidth BW4 of the ATM switching network 2 is decided on as the changed available bandwidth BW5 (step m) and an information (INFO) message containing this BW5 is sent to the two terminal equipment 4-1 and 4-2 (step l).

If the changed communication bandwidth BW1' from the terminal equipment 4-2 is smaller than the changed communication bandwidth BW0' from the terminal equipment 4-1 and is smaller than the changed communication bandwidth BW4 (YES at step n), the changed bandwidth BW1' from the terminal equipment 4-2 is decided on as the changed available bandwidth BW5 (step o) and an information (INFO) message containing this BW5 is sent to the two terminal equipment 4-1 and 4-2 (step l).

If the changed communication bandwidth BW1' from the terminal equipment 4-2 is smaller than the changed communication bandwidth BW0' from the terminal equipment 4-1 and is larger than the changed communication bandwidth BW4 (NO at step n), the changed bandwidth BW4 of the ATM switching network 2 is decided on as the changed available bandwidth BW5 (step p) and an information (INFO) message containing this BW5 is sent to the two terminal equipment 4-1 and 4-2 (step 1).

The terminal equipment 4-1 and 4-2, by receiving the changed available bandwidth BW5 (steps q and r), enter a state of communication by the BW5 (steps s and t).

Step e and step e' In Fig. 16 are comprised of the five illustrated sub-steps, with step e and step e' being the same. Looking at step e, this corresponds to the function of the judgement means 41 of Fig. 7. Step e3 decides on BW0 as BW0'. At step e4, when BW4 is smaller than the minimum bandwidth which can be used for communication by the terminal equipment 4-1, that minimum bandwidth of communication is decided on as BW0'. At times other than this, BW4 is decided on as BW0'. At step e5, a bandwidth smaller than BW4 and the maximum bandwidth of communication for the terminal equipment 4-1 is decided on as the BW0'.

Figure 17 is a view of an example of a processing sequence executed in the system of the present invention. It shows the control sequence during call setup and communication. It assumes the case where the terminal equipment 4-1 sends the information of the bandwidth BW0 to the terminal equipment 4-2.

First, the terminal equipment 4-1 sends a call setup (SETUP) message to the ATM switching network 2 ([1]). This call setup message contains information on the type of communication, showing whether the communication is CBR communication or VBR communication, the maximum bandwidth requested, i.e. the communication bandwidth BW0, and whether the bandwidth used can be changed.

Receiving the call setup (SETUP) message, the ATM switching network 2 returns a call processing (CALL PROC) message to the terminal equipment 4-1 ([2]). Then, the ATM switching network 2 decides, by performing the processing from step a to step h of Fig. 14A on the allocable bandwidth BW1 showing the bandwidth which can be currently provided as recognized by the management apparatus 3 and the communication bandwidth BW0 requested from the terminal equipment 4-1, the allocable bandwidth BW0 or BW1. Then, it inserts this allocable bandwidth BW0 or BW1 in the call setup (SETUP) message to the terminal equipment 4-2 and sends it to the terminal equipment 4-2.

The terminal equipment 4-2, when receiving the call setup (SETUP) message, returns an alert message to the terminal equipment 4-1 ([4] and [5]). The terminal equipment 4-2 decides on whether to perform the communication by VBR communication or by CBR communication by the processing from step a to step p of Figs. 15A and 15B and decides on the available bandwidth BW3. Then, it returns to the terminal equipment 4-1 a message (one of CONN, REL, REL COM (release completion), or DISC) ([6]). When it sends the connection (CONN) message), it inserts information showing the type of communication, i.e., showing if the communication at the terminating side is CBR communication or VBR communication, the available bandwidth BW3 decided on, and whether the bandwidth used can be changed.

The ATM switching network 2 receives the connection (CONN) message and recognizes the type of communication and the available bandwidth BW3. Then, it notifies the connection (CONN) message as is to the terminal equipment 4-1 ([7]).

The terminal equipment 4-1 receives this received connection (CONN) message, recognizes the type of communication and the available bandwidth BW3, and enters a communication state based on these conditions. Then, it sends back a connection acknowledge (CONN ACK) message showing the connection state to the terminal equipment 4-2 ([8] and [9]).

The terminal equipment 4-2, by receiving this connection acknowledge (CONN ACK) message from the terminal equipment 4-1, enters the communication state under the conditions inserted in the connection (CONN) message.

Next, an explanation will be given of the flow of processing for change of the bandwidth in the case where the line connection is designated as VBR communication and variable. The state of traffic of the ATM switching network 2 is always changing and assumption is made of the case of change of the allocable bandwidth of the ATM switching network 2 from BW3 to BW4.

The ATM switching network 2 inserts the changed bandwidth BW4 in the information (INFO) message at the step b of Fig. 16A and notifies the same to the terminal equipment 4-1 and 4-2 ([1]').

Receiving this, the terminal equipment 4-1 and 4-2 respectively insert the changed communication bandwidth BW0' and BW1' to the ATM switching network 2 in the information (INFO) message and send the same to the ATM switching network 2 ([2]' and [3]').

The ATM switching network 2 performs the processing of step h to step 1 of Fig. 16B and Fig. 16C and uses the changed communication bandwidths BW0' and BW1' received to decide on the changed available bandwidth BW5. Then, it inserts the changed available bandwidth BW5 in the information (INFO) message and sends it to the terminal equipment 4-1 and 4-2 ([4]').

The BW5 which is decided on is set by the ATM switching network 2 in the management apparatus 3 and by the terminal equipment 4-1 and 4-2 in the memories 420.

In this way, it is possible to change the allocable bandwidth in accordance with changes in the state of traffic of the ATM switching network 2 even during communication

Further, when it is desired to know the requested communication bandwidth of the originating terminal equipment 4-1 at the terminating terminal equipment 4-2 in call setup, the ATM switching network 2 may notify the terminating terminal equipment 4-2 of both the requested communication bandwidth of the originating terminal equipment 4-1 and the allocable bandwidth of the ATM switching network 2.

Next, an explanation will be given of an example of the architecture of the ATM communication system shown in Fig. 7 and another specific example of the means mentioned above.

Figure 18 is a view showing an example of the system architecture of the present Invention. This is substantially equivalent to the constitution of Fig. 9 discussed earlier. Therefore, the same reference numerals are given to elements equivalent to the elements of Fig. 9.

The ATM communication system 1 shown in Fig. 18 is basically constructed of three independent layers. That is, it is constructed of:

(i) An ATM switching network 2 which accommodates a plurality of subscriber terminal equipment 4 and has a plurality of ATM exchanges 5 which can be linked with each other,
(ii) A management apparatus 3 which monitors and controls the traffic of cells exchanged in the ATM switching network 2 and transferred among the terminal equipment 4, and
(iii) A communication line layer 20 which transfers traffic control information between the management apparatus 3 and ATM switching network 2.

Further, specifically, a traffic monitoring means 7 which collects the traffic information TI of the cells is provided in the ATM exchanges 5 of the ATM switching network 2. Further, an analyzing means 31 which analyzes the state of traffic of the cells at the ATM switching network 2 based on traffic information TI obtained through the communication line iayer 20 is provided in the management apparatus 3. An optimal control means 32 for giving the optimal traffic control command CM to the ATM exchanges 5 in the ATM switching network 2 through the communication line layer 20 based on the results of analysis of the analyzing means 21 is provided in the management apparatus 3. A traffic control means 9 which executes the traffic control of cells in accordance with the optimal traffic control command CM given from the optimal control means 32 is provided in the ATM exchanges 5. The means 9 is provided with a notifying means 6 which sends an indication signal IS for controlling the amount of transmission of ceils in the corresponding terminal equipment 4.

In this way, the ATM communication system is first roughly divided into the ATM switching network 2 and the management apparatus 3 to facilitate the cell traffic control.

The management apparatus 3 places the ATM exchanges 5 all under its control, sums up and monitors the traffic of all the cells in the ATM switching network 2, and gives a suitable traffic control command to all the ATM exchanges 5 based on the results of this monitoring.

Therefore, it is possible to handle the unique cell traffic inherent of ATM.

Figure 19 is a view showing the specific concept based on the system architecture of Fig. 18.

In Fig. 19, it will be understood that the management apparatus 3 is positioned higher than the ATM switching network 2. At the lower ATM switching network 2, the ATM exchanges 5 are in actuality constituted by a central office (CO) and remote electronics (RE).

The ATM exchanges 5 (CO, RE) are provided with the traffic monitoring means 7 shown in Fig. 18. The traffic information collected by these means 7 is fetched by the higher level management apparatus 3 through the communication line layer 20. Note that the communication line layer 20 may be either wired or wireless.

The management apparatus 3 is in actuality comprised of at least one traffic control center (TCC) 33, which center 33 includes at least the above-mentioned analyzing means 31 for analyzing the traffic information TI fetched from the ATM exchanges 5 and an optimal control means 32. When there are two or more traffic control centers (TCC) 33,

contact is maintained among the centers 33 regarding the traffic information TI as well.

If the specific concept of the conventional telephone network (line switching or packaging switching network) is drawn as in Fig. 19, it would not be a three-dimensional structure as in that figure, but just a two-dimensional structure. That is, there would be no management apparatus 3 or communication line layer 20, and the functional portions corresponding to the units 3 and 20 would be completely buried in the individual central offices (corresponding to CO in Fig. 19) forming the centers of the telephone network.

Figure 20 is a view of the concept of the ATM exchange. There is basically no great difference from a general electronic exchange. That is, the exchange is comprised of speech path circuitry 53 which performs the exchange of cells and sets the paths, control circuitry 54 which controls the setting of the paths, and a memory means 8.

Figure 21A, Fig. 21B, and Fig. 21C are views showing examples of realization of the speech path circuit in an ATM exchange. They show a first example (Fig. 21A), a second example (Fig. 21B), and a third example (Fig. 21C). Other examples are possible, but since this has no direct bearing on the gist of the present invention, just the above three examples are provided.

The first example is one called a self-rotating type, where the cells are transferred toward paths of the opposing terminal equipment side while selecting the self-rotating modules SRM.

The second example is one called a memory-switch type, where the cells are stored once in a buffer memory, then sent to paths designated by a path decision unit.

The third example is one called a broadcasting bus type, where a large number of nodes are connected to a plurality of paths, the cells are fetched at predetermined nodes, and the cells are sent out on the paths from the nodes.

Figure 22 is a view showing an example of a traffic monitor means. For ease of understanding, the portion surrounding the traffic monitoring means 7 is also drawn. The figure as a whole shows an ATM exchange 5.

The ATM exchange 5 is comprised of the speech path circuitry 53 and control circuitry 54 shown in Fig. 20, but the traffic monitoring means 7 is inserted here. The control circuitry 54 is comprised of a central control unit (CC) 54 and a memory 8. The speech path circuitry 53, if illustrated in concept, distributes cells CL (shown by o mark in figure) received from the left of the figure from a distribution unit 531 under the control of the central control unit and stores them once in a queue buffer 532 for a predetermined path. The cells CL stored here are sent out to the right side of the figure in order after that.

The traffic monitoring means 7 cooperating with the speech path circuitry 53 is, for example, provided with a passing cell counter 711, an abandoned cell counter 712, and a buffer usage rate counter 713, the count data from the counters being collected in the central control unit CC through the transfer circuit 714.

How many cells CL have been fetched in the speech path circuitry 53 (passing cell counter 711), how many cells CL have been erased by the following cells CL in the queue buffers 532 due to the increase of the cell traffic (abandoned cell counter 712), and what percent of the maximum capacity of the queue buffers on an average the amount of the cells CL stored at all times in the queue buffers 532 constitute (buffer usage rate counter 713) become the basic data showing the state of traffic of the cells, which becomes in turn the above-mentioned traffic information TI. Note that the above-mentioned CC does not in principle perform direct traffic control by itself by the information TI, but immediately sends the information to the management apparatus 3. The above-mentioned communication line layer 20 exists for transmission of this.

Figure 23 is a view showing somewhat more specifically the upstream side of the communication line layer. The portion surrounding the communication line layer 20 is also drawn, so the figure as a whole shows in part the ATM communication system.

The traffic information TI obtained from the speech path circuitry 53 shown in Fig. 22 by the traffic monitoring means 7 illustrated is collected by the central control unit CC and then enters the communication line layer 20. First, it enters the information sending unit 201, then passes through an upstream line 202, and reaches an information receiving unit 203 at the end of the communication line layer 20. The received traffic information TI is input to the central processing unit (CPU) 34 forming the heart of the traffic control center (TCC) 33 shown in Fig. 19. The input information TI is supplied in the analyzing means 31 in the CPU 34. Note that the analyzing means 31 is supplied similarly with the traffic information TI from the other ATM exchanges 5 in the ATM switching network 2 through the corresponding upstream lines 201 and information receiving units 203.

Note that reference numeral 403 in the figure is a path setting path control line for connecting the speech path circuitry 53 and the central control unit (CC) 54.

Figure 24 is a view showing somewhat more specifically the downstream side of the communication line layer. The optimal traffic control information based on the results of analysis by the analyzing means 31 of Fig. 23 is produced by the optimal control unit 32 in the CPU 34. This is used as the command CM and indicates the system for sending information to the ATM switching network 2 side. First, it enters a command sending unit 205, then passes through a downstream line 206, and reaches a command receiving unit 207 at the end of the communication line layer 20. The command receiving unit 207 is in the ATM switching network 2 and gives the optimal traffic control command CM to the central control unit (CC) 54 in the ATM exchange 5. The command CM is supplied to the traffic control means 9,

based on which command CM the traffic control is performed for the speech path circuitry 53. The means 9 drives the notifying means 6 and sends an instruction signal IS to the corresponding terminal equipment 4.

Figure 25 is a view showing somewhat more specifically the traffic control center. The surrounding portion is also drawn. Note that the apparatus 203 of Fig. 6 and the apparatus 205 of Fig. 24, the surrounding portions, are actually comprised of a single unit, so Fig. 25 shows the apparatuses 203 and 205 as a single sending and receiving unit. Further, the analyzing means 31 and the optimal control means 32 are shown as a single unit in the CPU 34.

The central processing unit (CPU) 34 cooperates with a main memory (MM) 36 and a file memory (FM) 37. The main memory (MM) 36 stores analysis programs for operating the analyzing means 31 and command programs for operating she optimal control means 32 and also traffic information (TI) data and analyzed processed data. Other general programs for controlling various other operations are of course also stored together in the main memory (MM) 36.

On the other hand, the file memory (FM) 37 holds the reference data required for issuing a command from the optimal control means 32 for the results of analysis from the analyzing means 31.

Figure 26A is a view showing schematically the operation of an analyzing means in a central processing unit, and Fig. 26B is a view showing schematically the operation of an optimum control means in the central processing unit. The processing of Fig. 26B is executed after the analysis processing shown in Fig. 26A by the central processing unit (CPU) 34 shown in Fig. 26A.

In Fig. 26A, traffic information transfer processing (step a) for fetching traffic information TI from the sending and receiving units 208 corresponding to the ATM exchanges shown in Fig. 25 is continuously repeated.

The traffic information (so-called raw data) fetched at step a is stored once at a predetermined address in the main memory (MM) 36 as data [1], data [2]... data [n].

The data fetched at step a and accumulated in the main memory (MM) 36 is subjected to processing at step b. Step b is processing for analyzing the above accumulated data and applies various types of processing to the data. The processed data is stored in other areas of the same main memory (MM) 36 as the data "a", "b", ... "x" corresponding to the data [1], [2]... [n]. Note that the "processing" of data spoken of here means, for example, the calculation of cumulative number of cells CL passing in a certain time period or the calculation of the usage rate of queue buffers (532 in Fig. 22) in a certain period (calculation by maximum number and minimum number of cells contained in queue buffers).

When the above-mentioned analysis processing of the traffic is finished, steps c, d, e, f, and g in Fig. 26 start. These steps are processing for issuing the above-mentioned optimal traffic control command CM. The command CM, specifically, for example, is made in the form of issuance of orders for "activation" and "release", with the "activation" order commanding the corresponding ATM exchange 5 to suppress the flow of cells and the "release" order commanding it to return the flow which has been suppressed to the normal level of flow. The judgement as to the "activation" and "release" orders is made at step d and step f of Fig. 26B and these are issued at step e and step g, respectively.

Judgement as to the above activation and release orders requires comparison of the preset reference data and the above-mentioned processed data. Giving an example, if a maximum reference value of 70 percent and a minimum reference value of 30 percent is set for a queue buffer 532, then an "activation" order is issued when it is judged that the usage rate of the queue buffer is over 70 percent and a "release" order is issued when the rate has fallen under 30 percent. So-called hysterisis is given to give stability to the control of the flow of cells. The above-mentioned file memory (FM) 37 holds the above reference data, which is read out at step c and used for the judgement of the activation or release order.

Figure 27 is a view showing an ATM exchange operating receiving the optimum traffic control command. The exchange is substantially the same as the ATM exchange 5 shown in Fig. 23 and Fig. 24, but a signal generating unit (SGU) 61 cooperating with the notifying means 6 is further shown. The signal generating unit 61, which is controlled by the means 6, sends out a signal to the corresponding terminal equipment 4 which is sending out cells so as to command that the interval of sending of the cells be lengthened (during activation) or that it be returned to its original state (release etc.). This is performed through the D-channel of the ISDN.

As the activation actions which the traffic control means 9 performs when receiving an optimal traffic control command CM, in particular an "activation" command, through the central control unit 54, there may be mentioned:

(i) A cell abandonment instruction (clearing all cells in queue buffer 532),
(ii) A cell detour instruction (rewriting VCI table (not shown) in speech path circuitry 53), and
(iii) A passing cell priority instruction (abandonment from cells carrying low priority flags).

Finally, an explanation will be made of a specific example of the traffic control means.

Figure 28 is a view showing a specific example of the traffic control means. It shows more specifically the means 9 in Fig. 8B. The threshold generating unit 91 in Fig. 8B is comprised of a multiplier 921 and a threshold register 922. A comparing unit 93 is comprised of a digital comparator 931.

At the time of call setup, call control data send from a terminal equipment is applied to a signal processing circuit 902 provided for processing the same. The circuit 902 fetches from the input data the available bandwidth information γ instructed from the terminal equipment and, at the same time, fetches the media classification information MD of the media for communication. The information MD shows, for example, the attributes of the communication data, for example, "compressed picture", "speech data without silence", "data", etc.

The above information γ and MD are input to a multiplier 921 and a safety factor table memory unit 91. The safety factor SF corresponding to the type of the media is read from the memory unit 91. Examples are provided below:

MD	SF
Compressed picture data (coded between two adjacent frames)	1.4
Compressed picture data (coded inside each frame)	1.2
Speech data without silent term	1.0
Data	2.0

In short, the higher the burst nature of the information, the higher the SF is set, e.g., 2.0. The safety factor SF is multiplied by the multiplier 921 with the above-mentioned γ (SF.γ) and stored in the threshold register 922.

On the other hand, a bandwidth monitor 901 continuously monitors the amount of traffic of the communication data. This monitoring value and the stored value in the register 922 are applied to the comparison inputs of the comparator 931. If the result of the comparison is that the former value is larger than the latter value, a selector 941 (corresponding to the cell abandonment instruction unit 94) is switched by the output of the comparison and the amount of overflow of the traffic is abandoned. Therefore, the traffic is policed with a high degree of service.

As explained above, according to the present invention, it is possible to flexibly and efficiently use the available bandwidth in a B-ISDN according to changes in the state of the network.

Therefore, first, during call setup, since the allocable bandwidth which can be allocated from the ATM switching network side is notified to the terminal equipment side, even when a sufficient bandwidth cannot be secured, communication becomes possible at the minimum bandwidth which can be allowed and therefore unnecessary call setup operations with the ATM switching network side can be eliminated.

Second, even if the terminal equipment side is not allocated a sufficient available bandwidth during call setup, there is the possibility of securing a sufficient bandwidth during communication due to subsequent changes in the network state.

Third, looking from the network side, it is possible to reduce the traffic during communication during periods of congestion and therefore possible to quickly return from a congested state to a normal state.

Fourth, looking from the terminal equipment side, it is possible to leam the state of change of the bandwidth, not knowable up to now, so changes of the bandwidth used become easy.

Reference signs in the claims are intended for better understanding and shall not limit the scope.

Claims

1. An ATM communication system which includes

   an ATM switching network (2) which includes a plurality of ATM exchanges (5) and controls exchanges among a plurality of terminal equipments (4) and

   a management apparatus (3) which manages the traffic in the ATM switching network (2); characterised in that the ATM switching network (2) includes a notifying means (6) which notifies the terminal equipment (4) of the allocable bandwidth which can be used in accordance with the amount of traffic in the ATM switching network; and in that

   when the notified allocable bandwidth is a bandwidth wich can be used for their communication, the terminal equipment (4) is arranged to start the communication in the range of that bandwidth.

2. A system as set forth in claim 1, wherein

   the ATM switching network (2) including a traffic monitoring means (7) which monitors the amount of traffic in the ATM switching network and

   the management apparatus (3) includes an analyzing means (31) which analyzes the allocable bandwidth

which can be given to the terminal equipment (4) in accordance with the amount of traffic.

3. A system as set forth in claim 1, wherein the terminal equipment (4) includes judgement means (41) which judge whether the allocable bandwidth notified from the ATM switching network (2) is an bandwidth of a size allowable for their own communication.

4. A system as set forth in claim 1, wherein the terminal equipment (4) include request means (42) which request to the ATM switching network (2) the communication bandwidth required for their own communication.

5. A system as set forth in claim 1, wherein the ATM switching network (2)

includes memory means (8) which store the communication bandwidth requested by the terminal equipment and required for the communication of the terminal equipment (4) and further
includes a bandwidth changing means (10) which changes the bandwidth to a communication bandwidth stored in the memory means (8) when the allocable bandwidth expands to larger than that communication bandwidth during a call of the terminal equipment (4).

6. A system as set forth in any of claims 1, 3, 4 or 5, and

including in a first terminal equipment (4-1) and a second terminal equipment (4-2) which can communicate with each other, a first request means (42-1) and a second request means (42-2), which request a first communication bandwidth and a second communication bandwidth which they require to the ATM switching network side;
including in the ATM switching network (2) a traffic monitoring means (7) which monitors the amount of traffic in the ATM switching network; and
including in the management apparatus (3) an analyzing means (31) which analyzes the allocable bandwidth which can be given to the first and second terminal equipment (4-1) and (4-2) in accordance with the amount of traffic from the traffic monitoring means (7);
the first terminal equipment (4-1 and 4-2) being arranged respectively to send out the first communication bandwidth to the ATM switching network (2) from the first request means (42-1 and 42-2) when communication is required from the first to the second terminal equipment; wherein the ATM switching network is arranged to send the received first bandwidth together with the allocable bandwidth to the second terminal equipment;
the second terminal equipment is arranged to send the second communication bandwidth on receiving the allocable bandwidth and the first communication bandwidth;
the analysing means (31) in the management apparatus (3) is arranged to decide on a common available bandwidth for the first and second terminal equipment (4-1 and 4-2) based on the first and second communication bandwidths received through the ATM switching network (2) and the amount of traffic monitored by the traffic monitoring means (7); and wherein the notifying means (6) is provided in the ATM switching network (2) to notify the available bandwidth decided on, to the first and second terminal equipment (4-1 and 4-2).

7. A system as set forth in claim 6, wherein the first and second communication bandwidths are the maximum bandwidths expected to be necessary for the communication by the first and second terminal equipment (4-1 and 4-2).

8. A system as set forth in claim 6, wherein the first and second communication bandwidths are the mean values of the bandwidths expected to be necessary for the communication by the first and second terminal equipment (4-1 and 4-2).

9. A system as set forth in claim 6, wherein

the ATM switching network (2) includes a memory means (8) which stores the first and second communication bandwidths requested from the first and second terminal equipment (4-1 and 4-2) at the start of communication between the terminal equipment and
the analyzing means (31) includes a bandwidth changing means (10) which notifies the first and second terminal equipment (4-1 end 4-2) of a changed bandwidth comprising the current first and second communication bandwidths expanded to a new allocable bandwidth when judging during communication between the first and second terminal equipment (4-1 and 4-2) that the allocable bandwidth has expanded to the first and second communication bandwidths stored in the memory means (8).

10. A system as set forth in claim 6, wherein the first and second terminal equipment (4-1 and 4-2) include a first memory means (43-1) and a second memory means (43-2) which store respectively the first and second communication bandwidth requested to the ATM switching network (2) by them at the time of the start of communication.

11. A system as set forth in claim 6, wherein the first and second terminal equipment (4-1 and 4-2) include a first decision means (44-1) and a second decision means (44-2) which decide whether to start communication by the available bandwidth instructed from the ATM switching network (2).

12. A system as set forth in claim 6, wherein the traffic monitoring means (7) is provided in the ATM exchanges (5) of the ATM switching network (2).

13. A system as set forth in claim 12, wherein the management apparatus (3) is provided with an optimal control means (32) which produces optimal traffic control information based on the results of analysis by the analyzing means (31) and supplies the information to the ATM switching network (2).

14. A system as set forth in claim 13, wherein a traffic control means (9) which receives the optimal traffic control information supplied from the optimal control means (22) and performs the control of the traffic is provided in the ATM exchanges (5).

15. A system as set forth in claim 14, wherein a bandwidth changing means (10) which notifies the first and second terminal equipment (4-1 and 4-2) that the present available bandwidth allocated for the communication between the two will be changed based on the optimal traffic control information is provided in the ATM exchanges (5).

16. A system as set forth in claim 15, wherein the traffic control means (9) in the ATM exchanges (5) has

a safety factor table unit (91) which sets in advance the safety factor showing the range of allowance of fluctuations in the amount of traffic for each of the communication media which the first and second terminal equipment (4-1 and 4-2) handle and stores the set safety factors as a table;
a threshold generating unit (92) which generates a threshold value obtained by multiplying the available bandwidths by the corresponding safety factors for each of the communication media;
a comparing unit (93) which compares the amount of traffic obtained by the traffic monitoring means (7) and the threshold value obtained from the threshold generating unit (92); and
a cell abandonment indicating unit (94) which sends out a command for abandoning a communication cell between the first and second terminal equipment (4-1 and 4-2) in the ATM exchanges (5) when the result of the comparison by the comparing unit (93) is that the amount of traffic has exceeded the threshold value.

17. A system as set forth in claim 16, wherein the first and second terminal equipment (4-1 and 4-2) include media classification notifying means (45-1 and 45-2) which notify the classification of the communication media to the traffic control means (5).

18. A method for bandwidth allocation in an ATM Communication system comprising an ATM switching network for controlling exchanges between first and second terminal equipments and comprising a management apparatus for managing the traffic in the ATM switching network, comprising:

a step wherein when communication is to be performed between a first terminal equipment (4-1) and a second terminal equipment (4-2), a first communication bandwidth required for the communication is sent through a first request means (42-1) in the first terminal equipment on the originating side to an ATM switching network (2) at the start of the communication; and
a step wherein the ATM swichting network (2) side monitors the amount of traffic in the ATM switching network (2), analyzes the bandwidth allocable to the terminal, equipment in the ATM switching network (2), and characterised in that, when receiving the first communication bandwidth from the originating side first terminal equipment (4-1), the ATM switching network sends the received first communication bandwidth together with the allocable bandwidth to the terminating side second terminal equipment (4-2);
wherein the second terminal equipment (4-2), when receiving the allocable bandwidth and the first communication bandwidth, sends the second communication bandwidth which the second terminal equipment (4-2) requests for communication, through a second request means (42-2) in the equipment to the ATM switching network (2) side;
wherein the ATM switching network (2) decides on the available bandwidth to be commonly occupied by the

first and second terminal equipment (4-1 and 4-2) based on the first and second communication bandwidths and the allocable bandwidth; and
wherein the decided on available bandwidth is sent from the ATM switching network (2) side to the first and second terminal equipment (4-1 and 4-2).

19. A method as set forth in claim 18, which comprises:

a step wherein the first and second communication bandwidths sent from the first and second terminal equipment (4-1 and 4-2) at the start of the communication are stored at the ATM switching network (2) side;
a step wherein the first and second terminal equipment decide by decision means (44-1 and 44-2) whether the available bandwidth decided on and notified by the ATM switching network can be received;
a step wherein during the call between the first and second terminal equipment, the ATM switching network side detects if the allocable bandwidth exceeds the stored first and second communication bandwidths;
a step wherein when it detects that it exceeds the same, the ATM switching network side notifies the first and second terminal equipment side of the stored first and second communication bandwidths; and
a step wherein the first and second terminal equipment decide by their respective decision means (44-1 and 44-2) to change the presently used bandwidth.

20. An ATM communication system which includes

an ATM switching network (2) which includes a plurality of ATM exchanges (5) and controls exchanges among a plurality of terminal equipment (4); and
a management apparatus (3) which manages the traffic in the ATM switching network (2); characterised by
a communication line layer (20) which transfers information relating to traffic among the management apparatus and the ATM switching network; and
a notifying means (6) which is provided in the ATM switching network, receives the traffic information, and notifies the terminal equipment of the allocable bandwidth which can be used in accordance with the amount of traffic in the ATM switching network.

21. A system as set forth in claim 20, wherein

the ATM exchanges (5) include a traffic monitoring means (7) which monitors the amount of traffic in the ATM switching network (2) and
the management apparatus (3) includes an analyzing means (31) which analyzes the allocable bandwidth which can be given to the terminal equipment (4) in accordance with the amount of traffic.

22. A system as set forth in claim 21, wherein the management equipment (3) is provided with an optimal control means (32) which produces optimal traffic control information based on the results of analysis by the analyzing means (31) and supplies the information to the ATM exchanges (5).

23. A system as set forth in claim 22, wherein the ATM exchanges (5) are provided with traffic control means (9) which receive the optimal traffic control information supplied from the optimal control means (32) and controls the traffic.

24. A system as set forth in claim 23, wherein the ATM exchanges (5) are provided with a bandwidth changing means (10) which receives information from the traffic control means (9) and notifies the terminal equipment of a change in the allocable bandwidth.

25. A system as set forth in claim 23, wherein the traffic control means (9) has

a safety factor table unit (91) which presets safety factors showing the range of allowance of fluctuations of traffic for each communication medium handled by the terminal equipment (4) and stores these set safety factors as a table;
a threshold generating unit (92) which generates a threshold, obtained by multiplying the allocable bandwidth by the corresponding safety factors, for each of the communication medium;
a comparing unit (93) which compares the traffic obtained by the traffic monitoring means (7) and the threshold obtained from the threshold generating unit (92); and
a cell abandonment instruction unit (94) which issues an instruction for abandoning communication cells in the ATM exchanges (5) when the result of the comparison by the comparing unit is that the traffic exceeds the

threshold.

26. A system as set forth in claim 25, wherein the terminal equipment (4) has a media classification notifying means (45) which notifies the classification of the communication media to the traffic control means (9).

Patentansprüche

1. ATM-Kommunikationssystem, welches umfaßt:

   ein ATM-Vermittlungsnetz (2), welches eine Vielzahl von ATM-Vermittlungsstellen (5) enthält und Vermittlungsvorgänge zwischen einer Vielzahl von Stationsgeräten (4) steuert; und

   eine Verwaltungsvorrichtung (3), die den Verkehr in dem ATM-Vermittlungsnetz (2) verwaltet;

   dadurch gekennzeichnet, daß

   das ATM-Vermittlungsnetz (2) eine Benachrichtigungseinrichtung (6) umfaßt, die dem Stationsgerät (4) die zuweisbare Bandbreite berichtet, die entsprechend der Verkehrsmenge in dem ATM-Vermittlungsnetz (2) verwendet werden kann; und

   wenn die berichtete zuweisbare Bandbreite eine Bandbreite ist, die für deren Kommunikation verwendet werden kann, das Stationsgerät (4) angeordnet ist, um die Kommunikation in dem Bereich dieser Bandbreite zu starten.

2. System nach Anspruch 1, dadurch gekennzeichnet, daß

   das ATM-Vermittlungsnetz (2) eine Verkehrsüberwachungseinrichtung (7) umfaßt, die die Verkehrsmenge in dem ATM-Vermittlungsnetz überwacht; und

   die Verwaltungsvorrichtung (3) eine Analysiereinrichtung (31) umfaßt, die die zuweisbare Bandbreite analysiert,

   die dem Stationsgerät (4) gemäß der Verkehrsmenge gegeben werden kann.

3. System nach Anspruch 1, dadurch gekennzeichnet, daß die Stationsgeräte (4) eine Bestimmungseinrichtung (41) umfassen, die bestimmt, ob die zuweisbare Bandbreite, die von dem ATM-Vermittlungsnetz (2) berichtet wird, eine Bandbreite mit einer Größe ist, die für deren eigene Kommunikation zulässig ist.

4. System nach Anspruch 1, dadurch gekennzeichnet, daß die Stationsgeräte (4) eine Anforderungseinrichtung (42) umfassen, die von dem ATM-Vermittlungsnetz (2) die Kommunikationsbandbreite, die für deren eigene Kommunikation benötigt wird, anfordert.

5. System nach Anspruch 1,
   dadurch gekennzeichnet, daß
   das ATM-Vermittlungsnetz (2)

   eine Speichereinrichtung (8) umfaßt, die die Kommunikationsbandbreite speichert, die von dem Stationsgerät angefordert und für die Kommunikation des Stationsgeräts (4) benötigt wird, und ferner

   eine Bandbreitenänderungseinrichtung (10) umfaßt, die die Bandbreite auf eine Kommunikationsbandbreite ändert, die in der Speichereinrichtung (8) gespeichert ist, wenn die zuweisbare Bandbreite größer als diese Kommunikationsbandbreite während eines Anrufs des Stationsgeräts (4) wird.

6. System nach einem der Ansprüche 1, 3, 4 oder 5 und

   umfassend in einem ersten Stationsgerät (4-1) und in einem zweiten Stationsgerät (4-2), die miteinander kommunizieren können, eine erste Anforderungseinrichtung (42-1) und eine zweite Anforderungseinrichtung

(42-2), die eine erste Kommunikationsbandbreite und eine zweite Kommunikationsbandbreite anfordem, die sie auf der Seite des ATM-Vermittlungsnetzes benötigen;

umfassend in dem ATM-Vermittlungsnetz (2) eine Verkehrsüberwachungseinrichtung (7), die die Verkehrsmenge in dem ATM-Vermittlungsnetz überwacht; und

umfassend in der Verwaltungsvorrichtung (3) eine Analysiereinrichtung (31), die die zuweisbare Bandbreite analysiert, die dem ersten und zweiten Stationsgerät (4-1) und (4-2) gemäß der Verkehrsmenge von der Verkehrsüberwachungseinrichtung (7) gegeben werden kann;

wobei das erste Stationsgerät (4-1 und 4-2) jeweils angeordnet ist, um die erste Kommunikationsbandbreite an das ATM-Vermittlungsnetz (2) von der ersten Anforderungseinrichtung (42-1 und 42-2) auszusenden, wenn eine Kommunikation von dem ersten an das zweite Stationsgerät benötigt wird; wobei das ATM-Vermittlungsnetz angeordnet ist, um die empfangene erste Bandbreite zusammen mit der zuweisbaren Bandbreite an das zweite Stationsgerät zu senden;

das zweite Stationsgerät angeordnet ist, um die zweite Kommunikationsbandbreite beim Empfang der zuweisbaren Bandbreite und der ersten Kommunikationsbandbreite zu senden;

die Analysiereinrichtung (31) in der Verwaltungsvorrichtung (3) angeordnet ist, um eine gemeinsame verfügbare Bandbreite für das erste und zweite Stationsgerät (4-1 und 4-2) auf Grundlage der ersten und zweiten Kommunikationsbandbreiten, die durch das ATM-Vermittlungsnetz (2) empfangen werden, und der Verkehrsmenge, die von der

Verkehrsüberwachungseinrichtung (7) überwacht wird, zu bestimmen; und wobei die Benachrichtigungseinrichtung (6) in dem ATM-Vermittlungsnetz (2) vorgesehen ist, um die verfügbare Bandbreite, die bestimmt wurde, an das erste und zweite Stationsgerät (4-1 und 4-2) zu berichten.

7. System nach Anspruch 6,
dadurch gekennzeichnet, daß
die ersten und zweiten Kommunikationsbandbreiten die maximalen Bandbreiten sind, von denen angenommen wird, daß sie für die Kommunikation von dem ersten und zweiten Stationsgerät (4-1 und 4-2) notwendig sind.

8. System nach Anspruch 6,
dadurch gekennzeichnet, daß
die ersten und zweiten Kommunikationsbandbreiten die Durchschnittswerte der Bandbreiten sind, von denen erwartet wird, daß sie für die Kommunikation von dem ersten und zweiten Stationsgerät (4-1 und 4-2) notwendig sind.

9. System nach Anspruch 6,
dadurch gekennzeichnet, daß

das ATM-Vermittlungsnetz (2) eine Speichereinrichtung (8) umfaßt, die die ersten und zweiten Kommunikationsbandbreiten speichert, die von dem ersten und zweiten Stationsgerät (4-1 und 4-2) zu Beginn einer Kommunikation zwischen den Stationsgeräten benötigt wird; und

die Analysiereinrichtung (31) eine Bandbreitenänderungseinrichtung (10) umfaßt, die das erste und zweite Stationsgerät (4-1 und 4-2) über eine geänderte Bandbreite umfassend die gegenwärtigen ersten und zweiten Kommunikationsbandbreiten, erweitert auf eine neue zuweisbare Bandbreite, informiert, wenn während einer Kommunikation zwischen dem ersten und zweiten Stationsgerät (4-1 und 4-2) bestimmt wird, daß sich zuweisbare Bandbreite auf die ersten und zweiten Kommunikationsbandbreiten, die in der Speichereinrichtung (8) gespeichert sind, erweitert hat.

10. System nach Anspruch 6,
dadurch gekennzeichnet, daß
das erste und zweite Stationsgerät (4-1 und 4-2) eine erste Speichereinrichtung (43-1) und eine zweite Speichereinrichtung (43-2) umfassen, die jeweils die erste und zweite Kommunikationsbandbreite speichern, die an dem ATM-Vermittlungsnetz (2) von ihnen zur Zeit des Beginns einer Kommunikation angefordert werden.

11. System nach Anspruch 6,
dadurch gekennzeichnet, daß
das erste und zweite Stationsgerät (4-1 und 4-2) eine erste Entscheidungseinrichtung (44-1) und eine zweite Entscheidungseinrichtung (44-2) umfassen, die entscheiden, ob eine Kommunikation mit der verfügbaren Bandbreite, die von dem ATM-Vermittlungsnetz (2) angewiesen wird, gestartet werden soll.

12. System nach Anspruch 6,
dadurch gekennzeichnet, daß
die Verkehrsüberwachungseinrichtung (7) in den ATM-Vermittlungsstellen (5) des ATM-Vermittlungsnetzes (2) vorgesehen ist.

13. System nach Anspruch 12,
dadurch gekennzeichnet, daß
die Verwaltungsvorrichtung (3) mit einer Optimalsteuereinrichtung (32) versehen ist, die auf Grundlage der Ergebnisse der Analyse von der Analysiereinrichtung (31) eine Steuerinformation für einen optimalen Verkehr erzeugt und die Information an das ATM-Vermittlungsnetz (2) liefert.

14. System nach Anspruch 13,
dadurch gekennzeichnet, daß
in den ATM-Vermittlungsstellen (5) eine Verkehrsteuereinrichtung (9) vorgesehen ist, die die Steuerinformation für einen optimalen Verkehr, die von der Optimalsteuereinrichtung (22) geliefert wird, empfängt und die Steuerung des Verkehrs ausführt.

15. System nach Anspruch 14,
dadurch gekennzeichnet, daß
in den ATM-Vermittlungsstellen (5) eine Bandbreitenänderungseinrichtung (10) vorgesehen ist, die das erste und zweite Stationsgerät (4-1 und 4-2) benachrichtigt, daß die gegenwärtig verfügbare Bandbreite, die für die Kommunikation zwischen den beiden zugewiesen ist, auf Grundlage der Steuerinformation über einen optimalen Verkehr geändert werden wird.

16. System nach Anspruch 15,
dadurch gekennzeichnet, daß
die Verkehrssteuereinrichtung (9) in den ATM-Vermittlungsstellen (5) aufweist:

eine Sicherheitsfaktor-Tabelleneinheit (91), die vorher den Sicherheitsfaktor einstellt, der den Bereich einer Zulässigkeit von Schwankungen in der Verkehrsmenge für jedes der Kommunikationsmedien anzeigt, die das erste und zweite Stationsgerät (4-1 und 4-2) behandeln, und die eingestellten Sicherheitsfaktoren als einer Tabelle speichert;

eine Schwellwert-Erzeugungseinheit (92), die einen Schwellwert, der durch Multiplizieren der verfügbaren Bandbreiten mit den entsprechenden Sicherheitsfaktoren erhalten wird, für jedes der Kommunikationsmedien erzeugt;

eine Vergleichseinheit (93), die die Verkehrsmenge, die von der Verkehrsüberwachungseinrichtung (7) ermittelt wird, und den Schwellwert, der von der Schwellwert-Erzeugungseinheit (92) ermittelt wird, vergleicht; und

eine Zellenabbruch-Anzeigeeinheit (94), die einen Befehl zum Abbruch einer Kommunikationszelle zwischen dem ersten und zweiten Stationsgerät (4-1 und 4-2) in den ATM-Vermittlungsstellen (5) aussendet, wenn das Vergleichsergebnis von der Vergleichseinheit (93) ist, daß die Verkehrsmenge den Schwellwert überschritten hat.

17. System nach Anspruch 16,
dadurch gekennzeichnet, daß
das erste und zweite Stationsgerät (4-1 und 4-2) eine Medienklassifizierungs-Benachrichtigungseinrichtung (45-1 und 45-2) umfaßt, die die Klassifizierung der Kommunikationsmedien an die Verkehrssteuereinrichtung (5) berichtet.

18. Verfahren für eine Bandbreitenzuweisung in einem ATM-Kommunikationssystem, umfassend ein ATM-Vermitt-

lungsnetz zum Steuem von Vermittlungsvorgängen zwischen ersten und zweiten Stationsgeräten und umfassend eine Verwaltungsvorrichtung zum Verwalten des Verkehrs in dem ATM-Vermittlungsnetz, umfassend:

einen Schritt, bei dem, wenn eine Kommunikation zwischen einem ersten Stationsgerät (4-1) und einem zweiten Stationsgerät (4-2) ausgeführt werden soll, eine erste Kommunikationsbandbreite, die für die Kommunikation benötigt wird, durch eine erste Anforderungseinrichtung (42-1) in dem ersten Stationsgerät auf der einleitenden Seite zu Beginn der Kommunikation an das ATM-Vermittlungsnetz (2) gesendet wird; und

einen Schritt, bei dem die Seite des ATM-Vermittlungsnetzes (2) die Verkehrsmenge in dem ATM-Vermittlungsnetz (2) überwacht, die dem Stationsgerät in dem ATM-Vermittlungsnetz (2) zuweisbare Bandbreite analysiert, und

dadurch gekennzeichnet, daß

das ATM-Vermittlungsnetz beim Empfangen der ersten Kommunikationsbandbreite von dem ersten Stationsgerät (4-1) der einleitenden Seite die empfangene erste Kommunikationsbandbreite zusammen mit der zuweisbaren Bandbreite an das zweite Stationsgerät (4-2) auf der abschließenden Seite sendet;

wobei das zweite Stationsgerät (4-2), beim Empfang der zuweisbaren Bandbreite und der ersten Kommunikationsbandbreite, die zweite Kommunikationsbandbreite, die das zweite Stationsgerät (4-2) für eine Kommunikation anfordert, durch eine Anforderungseinrichtung (42-2) in dem Gerät an die Seite des ATM-Vermittlungsnetzes (2) sendet;

wobei das ATM-Vermittlungsnetz (2) die verfügbare Bandbreite, die gemeinsam von dem ersten und zweiten Stationsgerät (4-1 und 4-2) belegt werden soll, auf Grundlage der ersten und zweiten Kommunikationsbandbreiten und der zuweisbaren Bandbreite bestimmt; und

wobei die bestimmte verfügbare Bandbreite von der Seite des ATM-Vermittlungsnetzes (2) an das erste und zweite Stationsgerät (4-1 und 4-2) gesendet wird.

19. Verfahren nach Anspruch 18, umfassend die folgenden Schritte:

einen Schritt, bei dem die ersten und zweiten Kommunikationsbandbreiten, die von dem ersten und zweiten Stationsgerät (4-1 und 4-2) zu Beginn der Kommunikation gesendet werden, auf der Seite des ATM-Vermittlungsnetzes (2) gespeichert werden;

einen Schritt, bei dem die ersten und zweiten Stationsgeräte durch eine Entscheidungseinrichtung (44-1 und 44-2) entscheiden, ob die verfügbare Bandbreite, die von dem ATM-Vermittlungsnetz bestimmt und berichtet wird, empfangen werden kann;

einen Schritt, bei dem während des Anrufs zwischen dem ersten und zweiten Stationsgerät die Seite des ATM-Vermittlungsnetzes erfaßt, ob die zuweisbare Bandbreite die gespeicherten ersten und zweiten Kommunikationsbandbreiten übersteigen;

einen Schritt, bei dem, wenn sie erfaßt, daß sie diese überschreitet, die Seite des ATM-Vermittlungsnetzes die Seite des ersten und zweiten Stationsgeräts über die gespeicherten ersten und zweiten Kommunikationsbandbreiten informiert; und

einen Schritt, bei dem die ersten und zweiten Stationsgeräte durch ihre jeweilige Entscheidungseinrichtung (44-1 und 44-2) entscheiden, die gegenwärtig verwendete Bandbreite zu ändern.

20. ATM-Kommunikationssystem, welches umfaßt:

ein ATM-Vermittlungsnetz (2), welches eine Vielzahl von ATM-Vermittlungsstellen (5) umfaßt und

Vermittlungsvorgänge zwischen einer Vielzahl von Stationsgeräten (4) steuert; und

eine Verwaltungsvorrichtung (3), die den Verkehr in dem ATM-Vermittlungsnetz (2) behandelt;

gekennzeichnet durch

eine Kommunikationsleitungsschicht (20), die Information bezüglich des Verkehrs zwischen der Verwaltungsvorrichtung und dem ATM-Vermittlungsnetz transferiert; und

eine Benachrichtigungseinrichtung (6), die in dem ATM-Vermittlungsnetz vorgesehen ist, die Verkehrsinformation empfängt und dem Stationsgerät die zuweisbare Bandbreite berichtet, die gemäß der Verkehrsmenge in dem ATM-Vermittlungsnetz verwendet werden kann.

21. System nach Anspruch 20,
dadurch gekennzeichnet, daß

die ATM-Vermittlungsstellen (5) eine Verkehrsüberwachungseinrichtung (7) umfassen, die die Verkehrsmenge in dem ATM-Vermittlungsnetz (2) überwacht; und

die Verwaltungsvorrichtung (3) eine Analysiereinrichtung (31) umfaßt, die die zuweisbare Bandbreite analysiert, die dem Stationsgerät (4) gemäß der Verkehrsmenge gegeben werden kann.

22. System nach Anspruch 21,
dadurch gekennzeichnet, daß
die Verwaltungsvorrichtung (3) mit einer Optimalsteuereinrichtung (32) versehen ist, die eine Steuerinformation für einen optimalen Verkehr auf Grundlage der Ergebnisse der Analyse von der Analysiereinrichtung (31) erzeugt und die Information an die ATM-Vermittlungsstellen (5) liefert.

23. System nach Anspruch 22,
dadurch gekennzeichnet, daß
die ATM-Vermittlungsstellen (5) mit einer Verkehrssteuereinrichtung (9) versehen sind, die die Steuerinformation für einen optimalen Verkehr, die von der Optimalsteuereinrichtung (32) geliefert wird, empfangen und den Verkehr steuern.

24. System nach Anspruch 23,
dadurch gekennzeichnet, daß
die ATM-Vermittlungsstellen (5) mit einer Bandbreitenänderungseinrichtung (10) versehen sind, die Information von der Verkehrssteuereinrichtung (9) empfängt, und das Stationsgerät über eine Änderung in der zuweisbaren Bandbreite informiert.

25. System nach Anspruch 23,
dadurch gekennzeichnet, daß
die Verkehrssteuereinrichtung (9) aufweist:

eine Sicherheitsfaktor-Tabelleneinheit (91), die Sicherheitsfaktoren voreinstellt, die den Bereich einer Zulässigkeit von Verkehrsschwankungen für jedes Kommunikationsmedium, welches von dem Stationsgerät (4) behandelt wird, anzeigen, und diese eingestellten Sicherheitsfaktoren als eine Tabelle speichert;

eine Schwellwert-Erzeugungseinheit (92), die einen Schwellwert, der durch Multiplizieren der zuweisbaren Bandbreite mit den entsprechenden Sicherheitsfaktoren ermittelt wird, für jedes Kommunikationsmedium erzeugt;

eine Vergleichseinheit (93), die den Verkehr, der von der Verkehrsüberwachungseinrichtung (7) ermittelt wird, und den Schwellwert, der von der Schwellwert-Erzeugungseinheit (92) ermittelt wird, vergleicht; und

eine Zellenabbruchs-Anweisung (94), die eine Anweisung zum Abbruch von Kommunikationszellen in den ATM-Vermittlungsstellen (5) ausgibt, wenn das Ergebnis des Vergleichs von der Vergleichseinheit ist, daß der Verkehr den Schwellwert übersteigt.

26. System nach Anspruch 25,
dadurch gekennzeichnet, daß
das Stationsgerät (4) eine Medienklassifikations-Benachrichtigungseinrichtung (45) aufweist, die der Verkehrs-

steuereinrichtung (9) die Klassifizierung der Kommunikationsmedien berichtet.

Revendications

1. Système de communication ATM comprenant

   un réseau de commutation ATM (2) comprenant une pluralité de centraux ATM (5) et commandant des échanges parmi une pluralité d'équipements terminaux (4), et
   un appareil de gestion (3) qui gère le trafic dans le réseau ATM (2); caractérisé en ce que le réseau de commutation ATM (2) comprend un moyen de notification (6) qui notifie à l'équipement terminal (4) la largeur de bande disponible pouvant être utilisée conformément à la densité du trafic dans le réseau de commutation ATM; et en ce que
   lorsque la largeur de bande disponible notifiée est une largeur de bande qui peut être utilisée pour leur communication, l'équipement terminal (4) est agencé pour débuter la communication de la plage de cette largeur de bande.

2. Système selon la revendication 1, dans lequel le réseau de commutation ATM (2) comprend un moyen de contrôle du trafic (7) qui contrôle la densité du trafic dans le réseau de commutation ATM et l'appareil de gestion (3) comprend un moyen d'analyse (31) qui analyse la largeur de bande disponible pouvant être accordée à l'équipement terminal (4) conformément à la densité du trafic.

3. Système selon la revendication 1, dans lequel les équipements terminaux (4) comprennent un moyen d'évaluation (41) qui évalue si la largeur de bande disponible notifiée depuis le réseau de commutation ATM (2) est une largeur de bande d'une dimension admissible pour leur propre communication.

4. Système selon la revendication 1, dans lequel les équipements terminaux (4) comprennent un moyen de demande (42) qui demande au réseau de commutation ATM (2) la largeur de bande de communication nécessaire pour leur propre communication.

5. Système selon la revendication 1, dans lequel le réseau de commutation ATM (2)

   comprend des moyens de mémoire (8) qui mémorisent la largeur de bande de communication demandée par l'équipement terminal et nécessaire pour la communication de l'équipement terminal (4) et en outre
   comprend un moyen de modification de largeur de bande (10) qui modifie la largeur de bande en une largeur de bande de communication mémorisée dans les moyens de mémoire (8) lorsque la largeur de bande disponible se dilate pour être supérieure à la largeur de bande de communication durant un appel de l'équipement terminal (4).

6. Svstème selon l'une quelconque des revendications 1, 3, 4 ou 5, et

   comprenant dans un premier équipement terminal (4-1) et dans un second équipement terminal (4-2) pouvant communiquer entre eux, un premier moyen de demande (42-1) et un second moyen de demande (42-2), qui demandent une première largeur de bande de communication et une seconde largeur de bande de communication qu'ils exigent du réseau de commutation ATM;
   comprenant dans le réseau de commutation ATM (2) un moyen de contrôle de trafic (7) qui contrôle la densité de trafic dans le réseau de commutation ATM; et
   comprenant dans l'appareil de gestion (3) un moyen d'analyse (31) qui analyse la largeur de bande disponible pouvant être accordée aux premier et second équipements terminaux (4-1) et (4-2) conformément à la densité du trafic provenant du moyen de contrôle de trafic (7);
   les premier et second équipements terminaux (4-1 et 4-2) étant agencés respectivement pour émettre la première largeur de bande de communication vers le réseau de commutation ATM (2) depuis les premiers moyens de demande (42-1 et 42-2) lorsqu'une communication est demandée par le premier équipement terminal au second équipement terminal; dans lequel le réseau de commutation ATM est agencé pour émettre la première largeur de bande reçue conjointement avec la largeur de bande disponible vers le second équipement terminal;
   le second équipement terminal étant agencé pour émettre la seconde largeur de bande de communication lors de la réception de la largeur de bande disponible et la première largeur de bande de communication;
   le moyen d'analyse (31) dans l'appareil de gestion (3) étant agencé pour décider d'une largeur de bande

disponible commune pour les premier et second équipements terminaux (4-1 et 4-2) en fonction des première et seconde largeurs de bande de communication reçues par l'intermédiaire du réseau de commutation ATM (2) et de la densité du trafic contrôlée par le moyen de contrôle de trafic (7); et dans lequel le moyen de notification (6) est prévu dans le réseau de commutation ATM (2) pour notifier la largeur de bande disponible décidée, aux premier et second équipements terminaux (4-1 et 4-2).

7. Système selon la revendication 6, dans lequel les première et seconde largeurs de bande de communication sont les largeurs de bande maximum estimées nécessaires pour la communication par les premier et second équipements terminaux (4-1 et 4-2).

8. Système selon la revendication 6, dans lequel les première et seconde largeurs de bande de communication sont les valeurs moyennes des largeurs de bande estimées nécessaires pour la communication par les premier et second équipements terminaux (4-1 et 4-2).

9. Système selon la revendication 6, dans lequel

le réseau de commutation ATM (2) comprend un moyen de mémoire (8) qui mémorise les première et seconde largeurs de bande de communication demandées par les premier et second équipements terminaux (4-1 et 4-2) au début de la communication entre les équipements terminaux et

le moyen d'analyse (31) comprend un moyen de modification de largeur de bande (10) qui notifie aux premier et second équipements terminaux (4-1 et 4-2) une largeur de bande modifiée comportant les première et seconde largeurs de bande de communication présentes dilatées en une nouvelle largeur de bande disponible lorsqu'il estime durant une communication entre les premier et second équipements terminaux (4-1 et 4-2) que la largeur de bande disponible a été dilatée aux première et seconde largeurs de bande de communication mémorisées dans le moyen de mémoire (8).

10. Système selon la revendication 6, dans lequel les premier et second équipements terminaux (4-1 et 4-2) comprennent un premier moyen de mémoire (43-1) et un second moyen de mémoire (43-2) qui mémorisent respectivement les première et seconde largeurs de bande de communication nécessaires au réseau de commutation ATM (2) par ceux-ci à l'instant du début d'une communication.

11. Système selon la revendication 6, dans lequel les premier et second équipements terminaux (4-1 et 4-2) comprennent un premier moyen de décision (44-1) et un second moyen de décision (44-2) qui décident de débuter une communication avec la largeur de bande disponible ordonnée par le réseau de commutation ATM (2).

12. Système selon la revendication 6, dans lequel le moyen de contrôle de trafic (7) est prévu dans les centraux ATM (5) du réseau de commutation ATM (2).

13. Système selon la revendication 12, dans lequel l'appareil de gestion (3) est équipé d'un moyen de contrôle optimal (32) qui délivre une information de contrôle de trafic optimal en fonction des résultats d'analyse par le moyen d'analyse (31) et délivre l'information au réseau de commutation ATM (2).

14. Système selon la revendication 13, dans lequel un moyen de contrôle de trafic (9) qui reçoit l'information de contrôle de trafic optimal délivrée par le moyen de contrôle optimal (22) et effectue le contrôle du trafic est prévu dans les centraux ATM (5).

15. Système selon la revendication 14, dans lequel un moyen de modification de largeur de bande (10) qui notifie aux premier et second équipements terminaux (4-1 et 4-2) que la largeur de bande disponible présentement allouée à la communication entre les deux sera modifiée en fonction de l'information de contrôle de trafic optimal est prévu dans les centraux ATM (5).

16. Système selon la revendication 15, dans lequel le moyen de contrôle de trafic (9) dans les centraux ATM (5) possède

une unité de table de coefficient de sécurité (91) qui fixe par avance le coefficient de sécurité présentant la plage admissible de fluctuations de la densité du trafic pour chacun des média de communication que traitent les premier et second équipements terminaux (4-1 et 4-2) et mémorise les coefficients de sécurité déterminés sous la forme d'une table;

une unité de génération de seuil (92) qui génère une valeur de seuil obtenue en multipliant les largeurs de bande disponibles par les coefficients de sécurité correspondants pour chacun des média de communication;
une unité de comparaison (93) qui compare la densité de trafic obtenue par le moyen de contrôle de trafic (7) et la valeur de seuil obtenue de l'unité de génération de seuil (92); et
une unité d'indication d'abandon de cellule (94) qui émet une commande pour abandonner une cellule de communication entre les premier et second équipements terminaux (4-1 et 4-2) dans les centraux ATM (5) lorsque le résultat de la comparaison par l'unité de comparaison (93) est que la densité du trafic a dépassé la valeur de seuil.

17. Système selon la revendication 16, dans lequel les premier et second équipements terminaux (4-1 et 4-2) comprennent des moyens de notification de classification de média (45-1 et 45-2) qui notifient la classification des média de communication au moyen de contrôle de trafic (5).

18. Procédé d'allocation de largeur de bande dans un système de communication ATM comportant un réseau de commutation ATM pour commander des échanges entre des premier et second équipements terminaux et comportant un appareil de gestion pour gérer le trafic dans le réseau de commutation ATM, comportant :

une étape dans laquelle, lorsqu'une communication doit être effectuée entre un premier équipement terminal (4-1) et un second équipement terminal (4-2), une première largeur de bande de communication nécessaire pour la communication est envoyée par l'intermédiaire d'un premier moyen de demande (42-1) dans le premier équipement terminal côté émetteur à un réseau de commutation ATM (2) au début de la communication; et
une étape dans laquelle le réseau de commutation ATM (2) contrôle la densité de trafic dans le réseau de commutation ATM (2), analyse la largeur de bande disponible pour l'équipement terminal dans le réseau de commutation ATM (2) et caractérisé en ce que, lorsqu'il reçoit la première largeur de bande de communication du premier équipement terminal émetteur (4-1), le réseau de commutation ATM émet la première largeur de bande de communication reçue conjointement avec la largeur de bande disponible au second équipement terminal récepteur (4-2);
dans lequel le second équipement terminal (4-2), lorsqu'il reçoit la largeur de bande disponible et la première largeur de bande de communication, émet la seconde largeur de bande de communication que demande le second équipement terminal (4-2) pour une communication, par l'intermédiaire d'un second moyen de demande (42-2) dans l'équipement vers le réseau de commutation ATM (2);
dans lequel le réseau de commutation ATM (2) décide de la largeur de bande disponible devant occupée communément par les premier et second équipements terminaux (4-1 et 4-2) en fonction des première et seconde largeurs de bande de communication et de la largeur de bande disponible; et
dans lequel la largeur de bande disponible décidée est envoyée depuis le réseau de commutation ATM (2) aux premier et second équipements terminaux (4-1 et 4-2).

19. Procédé selon la revendication 18, comportant:

une étape dans laquelle les première et seconde largeurs de bande de communication émises par les premier et second équipements terminaux (4-1 et 4-2) au début de la communication sont mémorisées dans le réseau de commutation ATM (2);
une étape dans laquelle les premier et second équipements terminaux décident par un moyen de décision (44-1 et 44-2) si la largeur de bande disponible décidée et notifiée par le réseau de commutation ATM peut être reçue;
une étape dans laquelle, durant l'appel entre les premier et second équipements terminaux, le réseau de commutation ATM détecte si la largeur de bande disponible dépasse les première et seconde largeurs de bande de communication mémorisées;
une étape, dans laquelle, lorsqu'il détecte que celle-ci est dépassée, le réseau de commutation ATM notifie aux premier et second équipements terminaux des première et seconde largeurs de bande de communication mémorisées; et
une étape dans laquelle les premier et second équipements terminaux décident grâce à leurs moyens de décision respectifs (44-1 et 44-2) de modifier la largeur de bande présentement utilisée.

20. Système de communication ATM comprenant

un réseau de commutation ATM (2) comprenant une pluralité de centraux ATM (5) et contrôlant des échanges entre une pluralité d'équipements terminaux (4); et

un appareil de gestion (3) qui gère le trafic dans le réseau de commutation ATM (2); caractérisé par
une couche de lignes de communication (20) qui transfère une information ayant trait au trafic parmi l'appareil de gestion et le réseau de commutation ATM; et
un moyen de notification (6) qui est prévu dans le réseau de commutation ATM, reçoit l'information de trafic et notifie à l'équipement terminal la largeur de bande disponible pouvant être utilisée conformément à la densité du trafic dans le réseau de commutation ATM.

21. Système selon la revendication 20, dans lequel

les centraux ATM (5) comprennent un moyen de contrôle de trafic (7) qui contrôle la densité de trafic dans le réseau de commutation ATM (2) et
l'appareil de gestion (3) comprend un moyen d'analyse (31) qui analyse la largeur de bande disponible pouvant être accordée à l'équipement terminal (4) conformément à la densité du trafic.

22. Système selon la revendication 21, dans lequel l'équipement de gestion (3) est équipé d'un moyen de contrôle optimal (32) qui délivre une information de contrôle de trafic optimal en fonction des résultats d'analyse par le moyen d'analyse (31) et délivre l'information aux centraux ATM (5).

23. Système selon la revendication 22, dans lequel les centraux ATM (5) sont équipés de moyens de contrôle de trafic (9) qui reçoivent l'information de contrôle de trafic optimal délivrée par les moyens de contrôle optimaux (32) et contrôlent le trafic.

24. Système selon la revendication 23, dans lequel les centraux ATM (5) sont équipés d'un moyen de modification de largeur de bande (10) qui reçoivent une information des moyens de contrôle de trafic (9) et notifient à l'équipement terminal une variation de la largeur de bande disponible.

25. Système selon la revendication 23, dans lequel le moyen de contrôle de trafic (9) possède

une unité de table de coefficients de sécurité (91) qui prédétermine des coefficients de sécurité représentant la plage autorisée de fluctuations du trafic pour chaque média de communication traité par l'équipement terminal (4) et mémorise ces coefficients de sécurité déterminés sous la forme d'une table;
une unité de génération de seuil (92) qui génère un seuil, obtenu en multipliant la largeur de bande disponible par les coefficients de sécurité correspondants, pour chacun des média de communication ;
une unité de comparaison (93) qui compare le trafic obtenu par le moyen de contrôle de trafic (7) et le seuil obtenu de l'unité de génération de seuil (92); et
une unité d'instruction d'abandon de cellule (94) qui délivre une instruction afin d'abandonner des cellules de communication dans les centraux ATM (5) lorsque le résultat de la comparaison par l'unité de comparaison est que le trafic dépasse le seuil.

26. Système selon la revendication 25, dans lequel l'équipement terminal (4) possède un moyen de notification de classification de média (45) qui notifie la classification des média de communication au moyen de contrôle de trafic (9).

Fig. 1

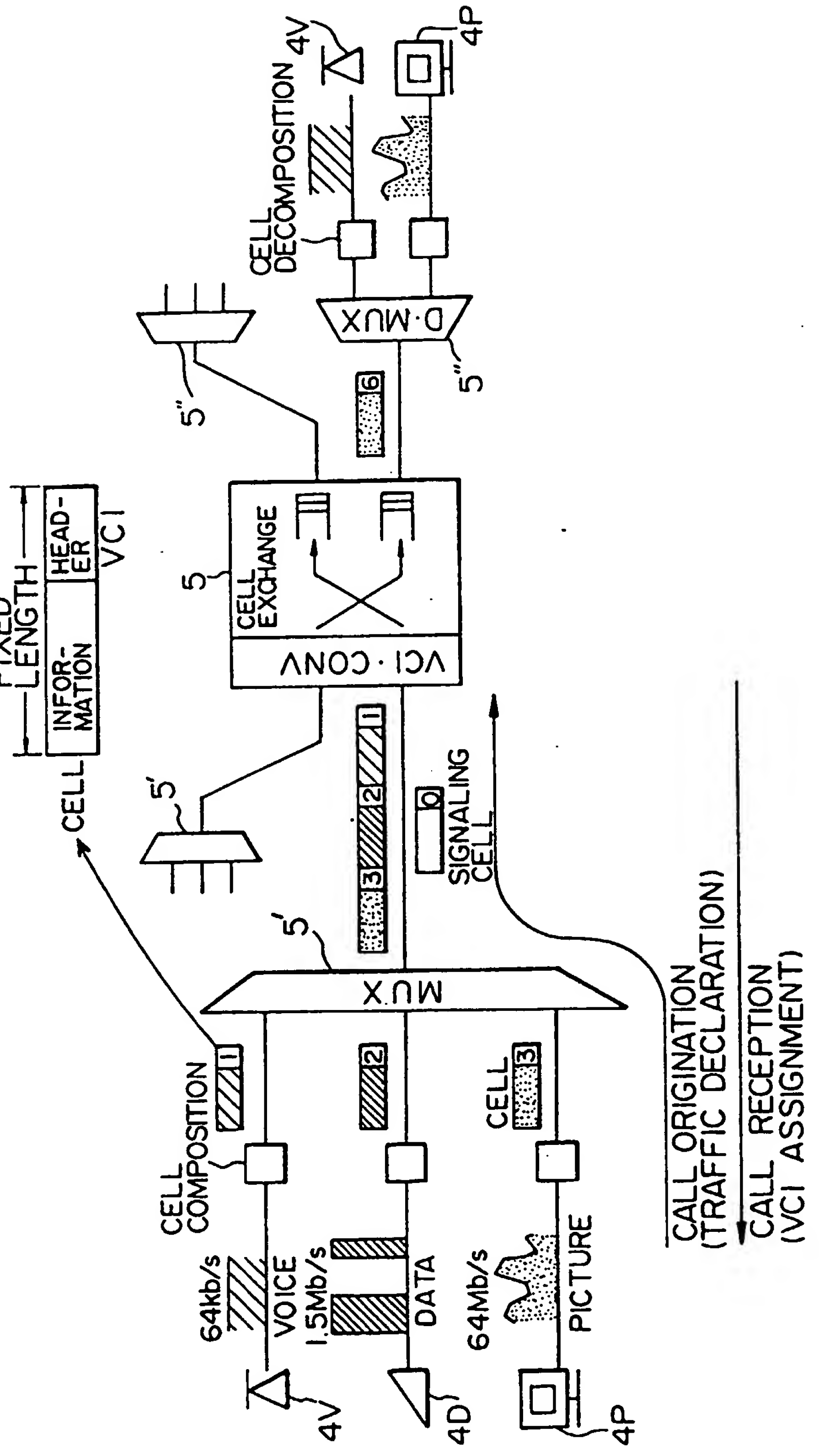

FIXED LENGTH
INFOR-MATION
HEAD-ER
VCI
CELL
CELL COMPOSITION
CELL
64kb/s
VOICE
1.5Mb/s
DATA
64Mb/s
PICTURE
4V
4D
4P
MUX
5'
5'
5
CELL EXCHANGE
VCI · CONV
SIGNALING CELL
5"
5"
D·MUX
CELL DECOMPOSITION
4V
4P
CALL ORIGINATION (TRAFFIC DECLARATION)
CALL RECEPTION (VCI ASSIGNMENT)

Fig. 2A

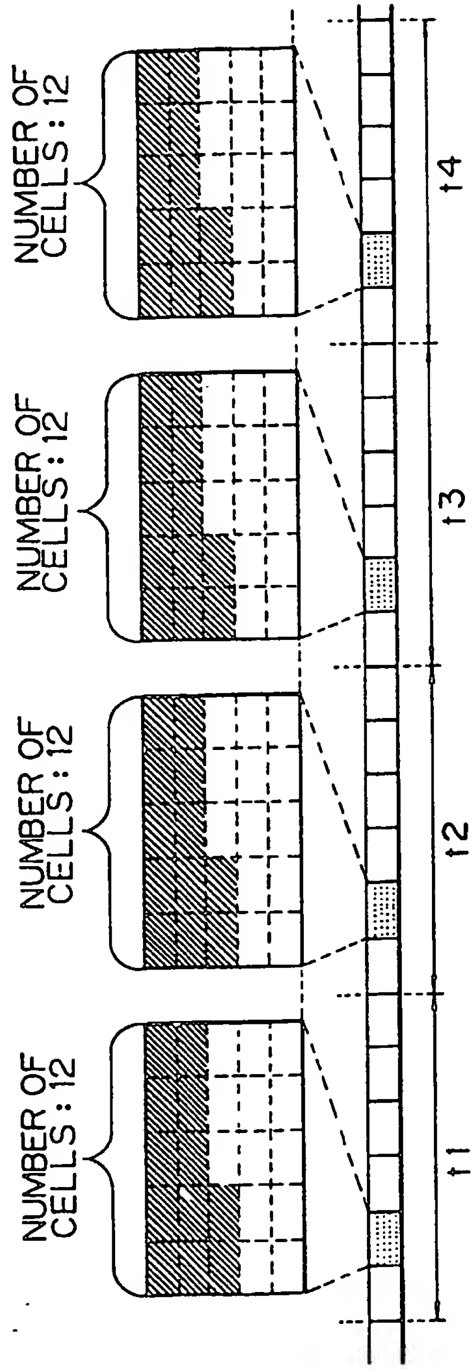

NUMBER OF CELLS : 12
NUMBER OF CELLS : 12
NUMBER OF CELLS : 12
NUMBER OF CELLS : 12
t1
t2
t3
t4

Fig. 2B

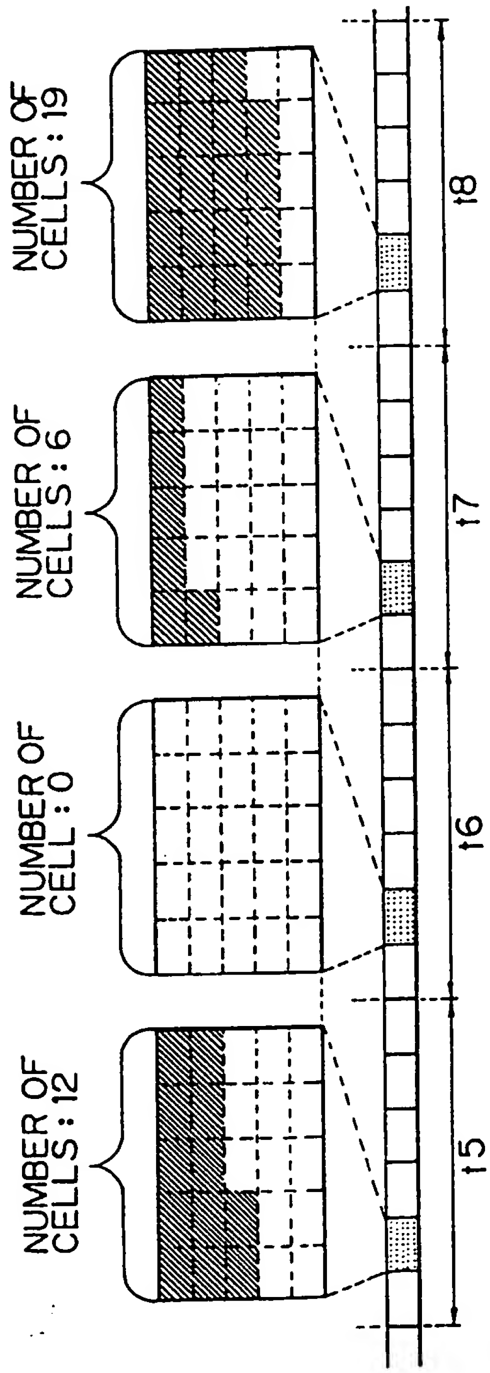

NUMBER OF CELLS : 12
NUMBER OF CELL : 0
NUMBER OF CELLS : 6
NUMBER OF CELLS : 19
t5
t6
t7
t8

Fig. 3

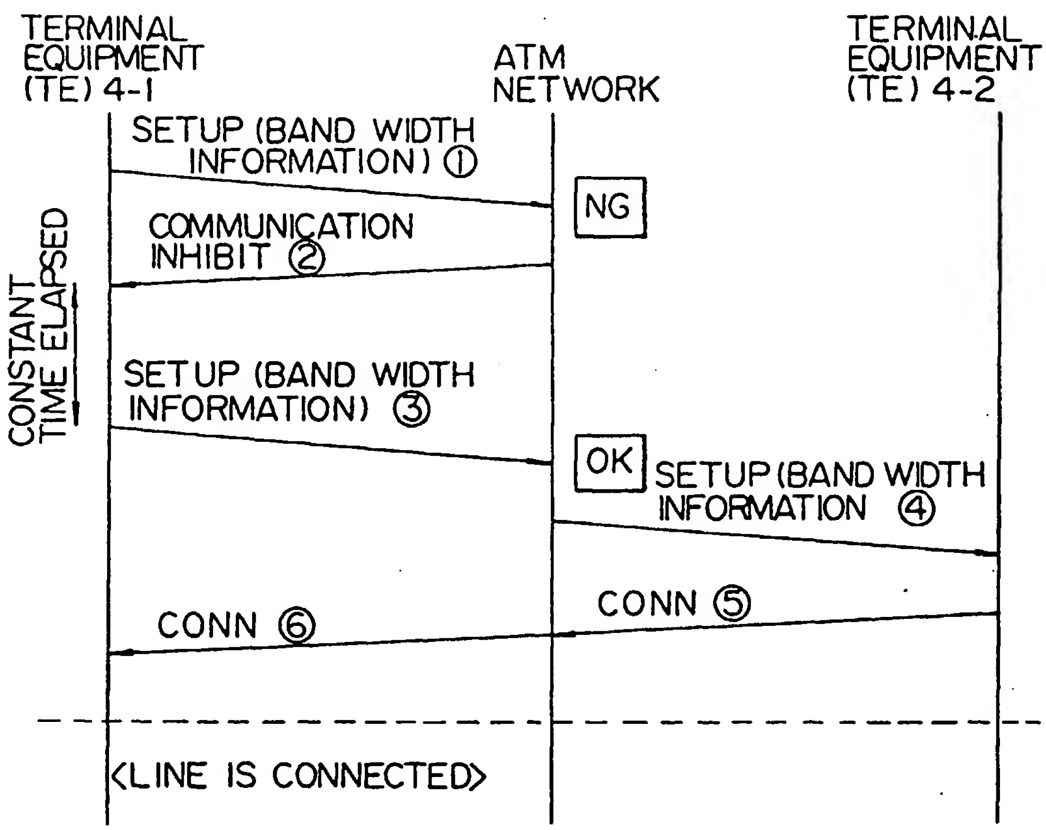

TERMINAL EQUIPMENT (TE) 4-1
ATM NETWORK
TERMINAL EQUIPMENT (TE) 4-2
SETUP (BAND WIDTH INFORMATION) ①
NG
COMMUNICATION INHIBIT ②
CONSTANT TIME ELAPSED
SETUP (BAND WIDTH INFORMATION) ③
OK
SETUP (BAND WIDTH INFORMATION ④
CONN ⑤
CONN ⑥
<LINE IS CONNECTED>

Fig. 4

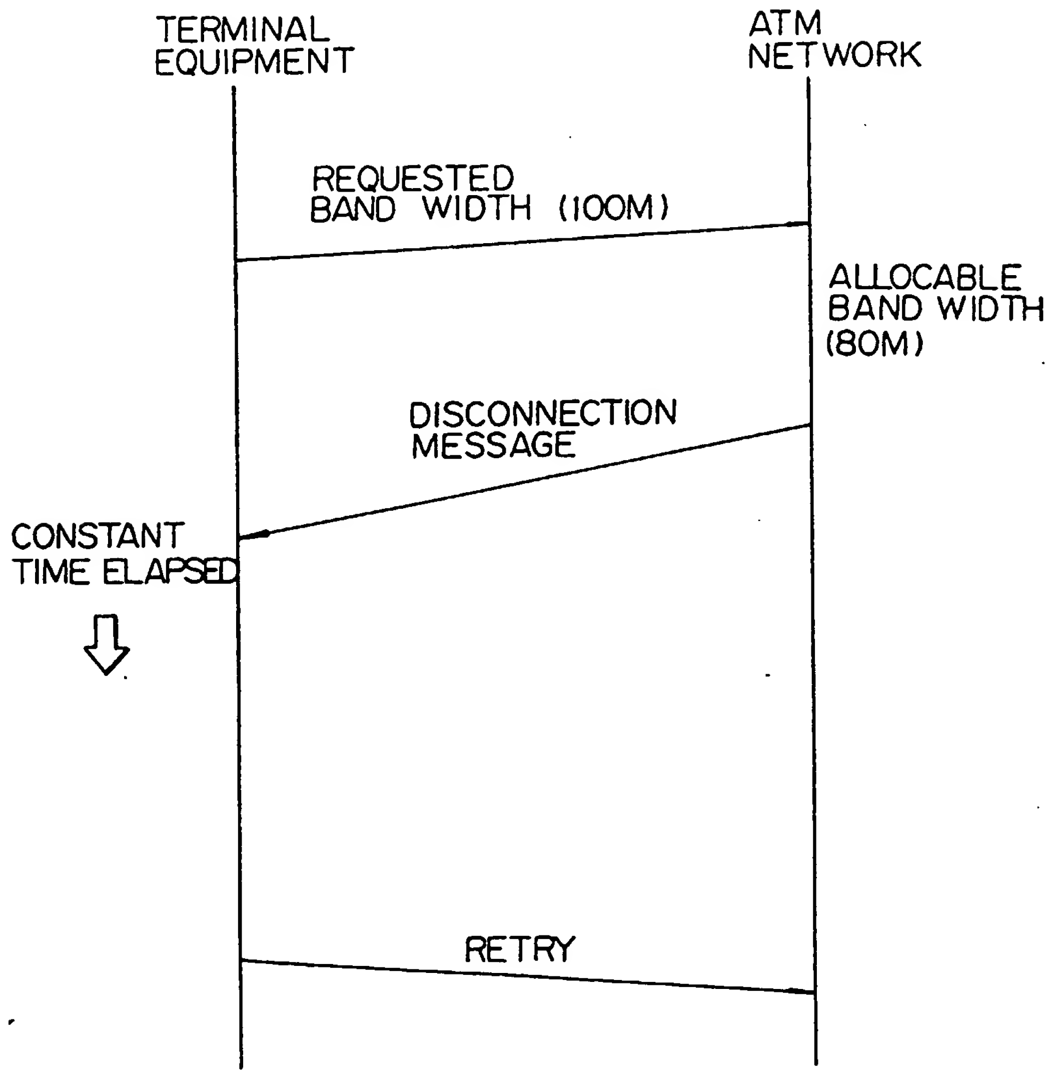

TERMINAL
EQUIPMENT
ATM
NETWORK
REQUESTED
BAND WIDTH (100M)
ALLOCABLE
BAND WIDTH
(80M)
DISCONNECTION
MESSAGE
CONSTANT
TIME ELAPSED
RETRY

Fig. 5

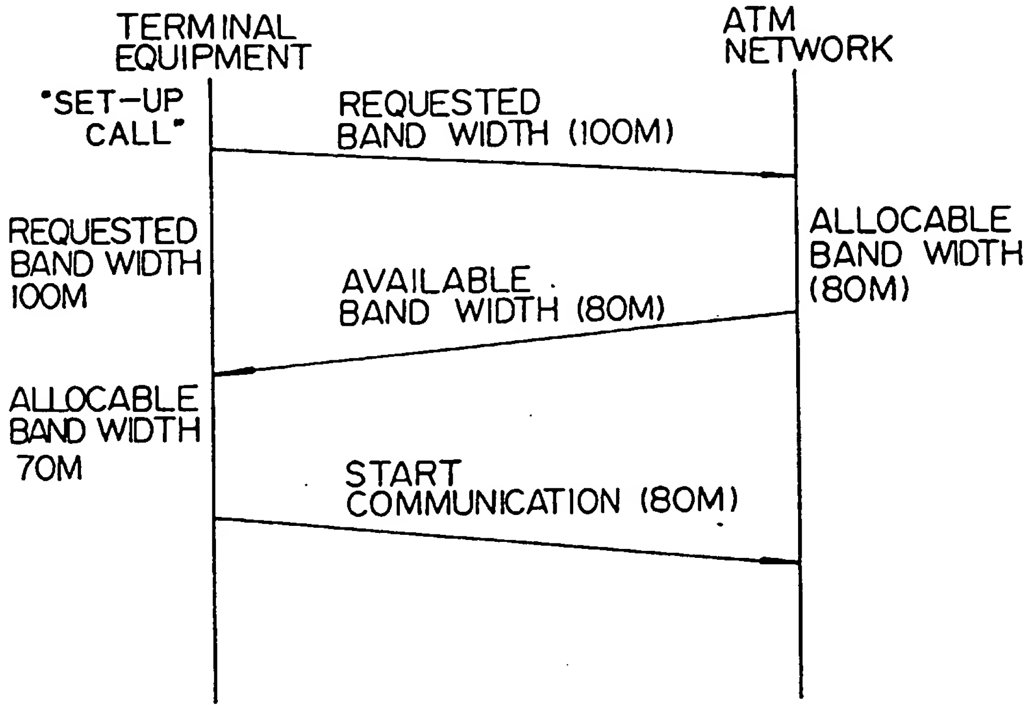

TERMINAL EQUIPMENT
ATM NETWORK
"SET-UP CALL"
REQUESTED BAND WIDTH (100M)
REQUESTED BAND WIDTH 100M
ALLOCABLE BAND WIDTH (80M)
AVAILABLE BAND WIDTH (80M)
ALLOCABLE BAND WIDTH 70M
START COMMUNICATION (80M)

Fig. 6

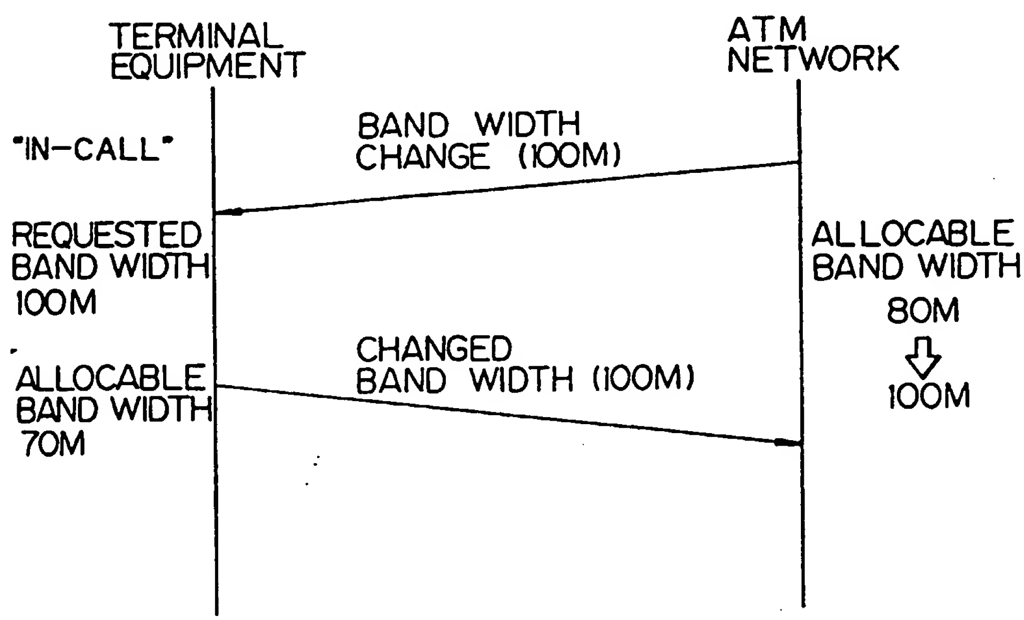

TERMINAL EQUIPMENT
ATM NETWORK
"IN-CALL"
BAND WIDTH CHANGE (100M)
REQUESTED BAND WIDTH 100M
ALLOCABLE BAND WIDTH 80M
100M
ALLOCABLE BAND WIDTH 70M
CHANGED BAND WIDTH (100M)

Fig. 7

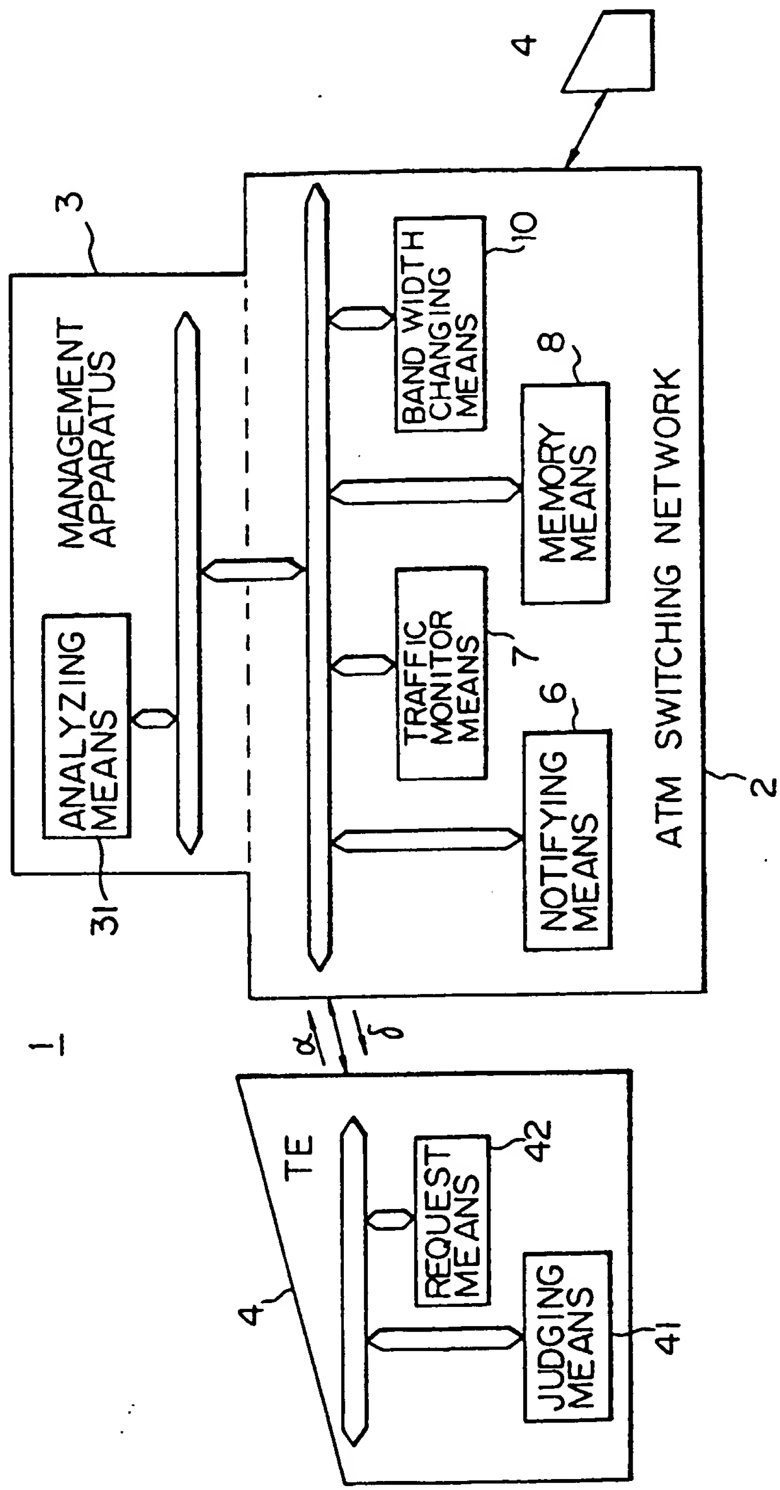

MANAGEMENT APPARATUS
3
ANALYZING MEANS
31
ATM SWITCHING NETWORK
2
BAND WIDTH CHANGING MEANS
10
MEMORY MEANS
8
TRAFFIC MONITOR MEANS
7
NOTIFYING MEANS
6
4
1
α
δ
TE
REQUEST MEANS
42
JUDGING MEANS
41
4

Fig. 8A

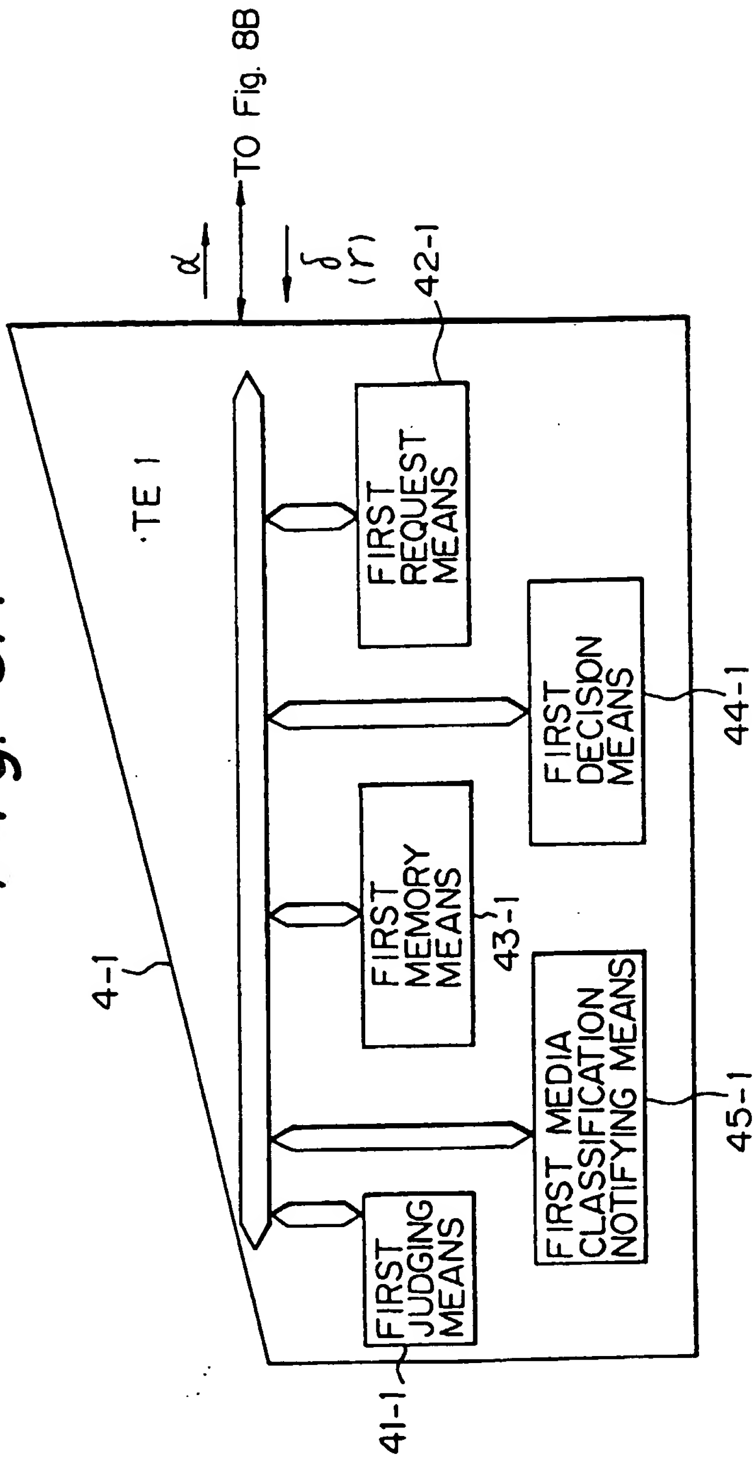
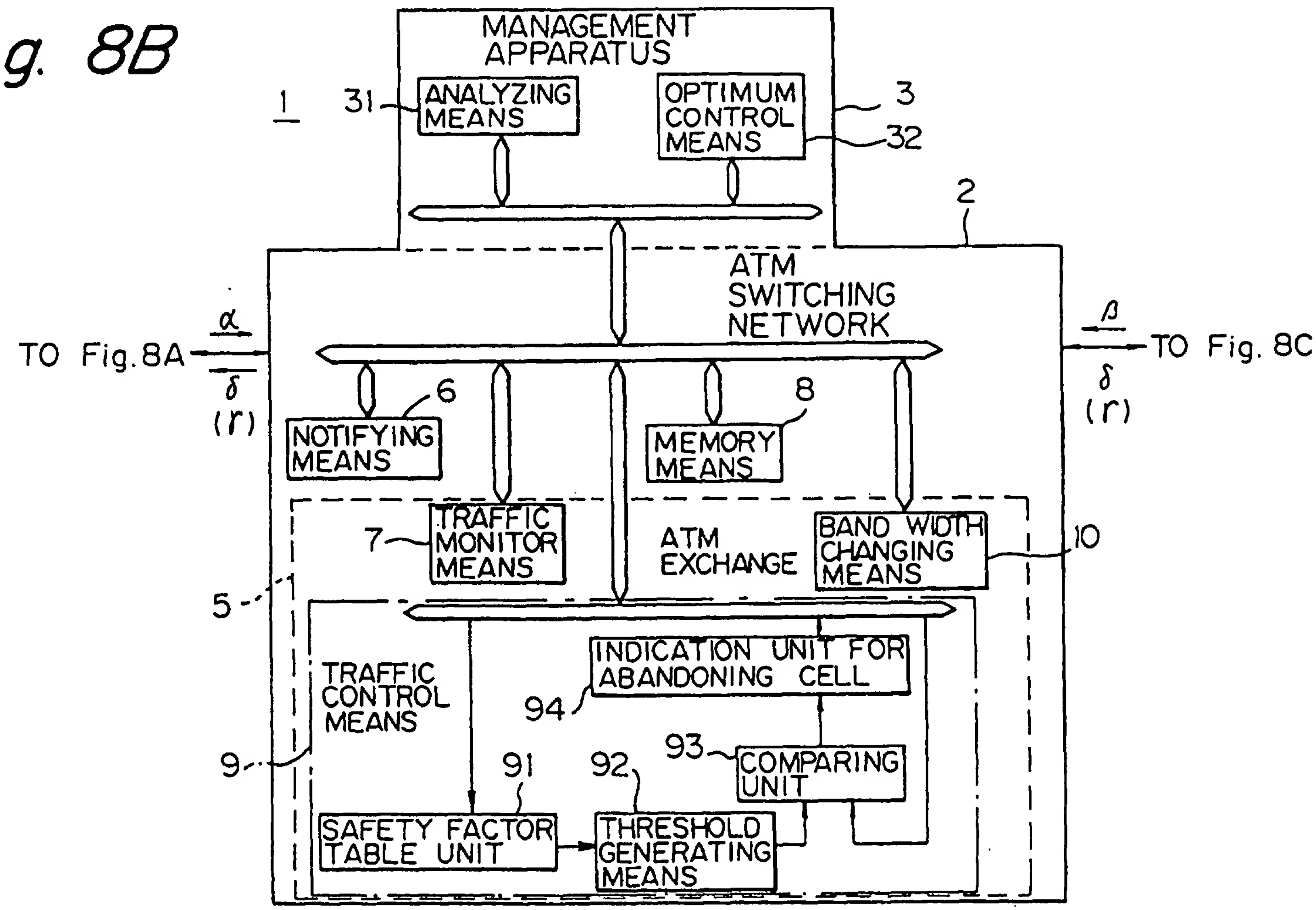

TO Fig. 8B
α
δ
(γ)
TE 1
4-1
FIRST REQUEST MEANS
42-1
FIRST DECISION MEANS
44-1
FIRST MEMORY MEANS
43-1
FIRST MEDIA CLASSIFICATION NOTIFYING MEANS
45-1
FIRST JUDGING MEANS
41-1

Fig. 8B


MANAGEMENT APPARATUS
1
31
ANALYZING MEANS
OPTIMUM CONTROL MEANS
3
32
2
ATM SWITCHING NETWORK
TO Fig.8A
α
δ
(r)
β
TO Fig. 8C
δ
(r)
NOTIFYING MEANS
6
MEMORY MEANS
8
TRAFFIC MONITOR MEANS
7
ATM EXCHANGE
BAND WIDTH CHANGING MEANS
10
5
INDICATION UNIT FOR ABANDONING CELL
94
TRAFFIC CONTROL MEANS
9
93
COMPARING UNIT
91
92
SAFETY FACTOR TABLE UNIT
THRESHOLD GENERATING MEANS

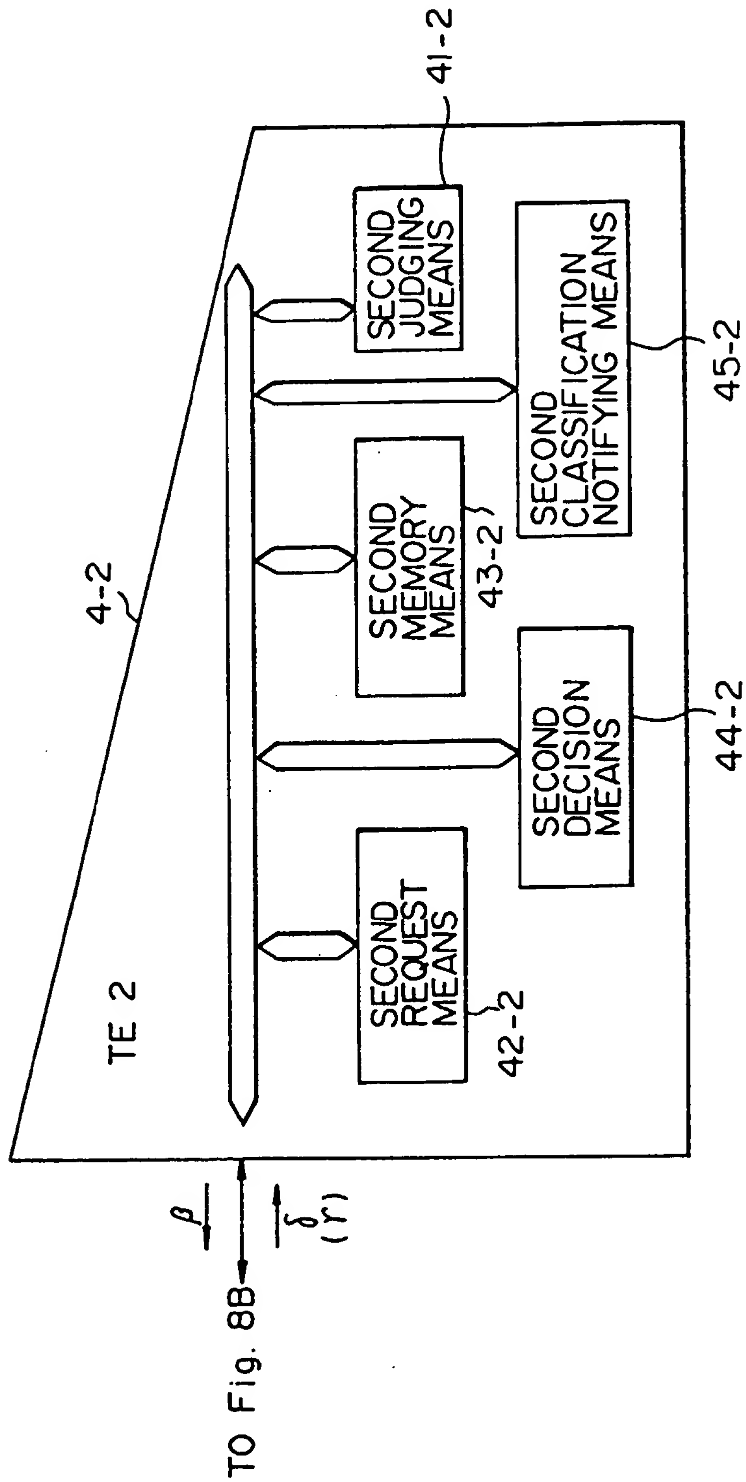

4-2
TE 2
SECOND JUDGING MEANS
41-2
SECOND MEMORY MEANS
43-2
SECOND REQUEST MEANS
42-2
SECOND CLASSIFICATION NOTIFYING MEANS
45-2
SECOND DECISION MEANS
44-2
β
δ
(γ)
TO Fig. 8B

Fig. 8C

Fig. 9

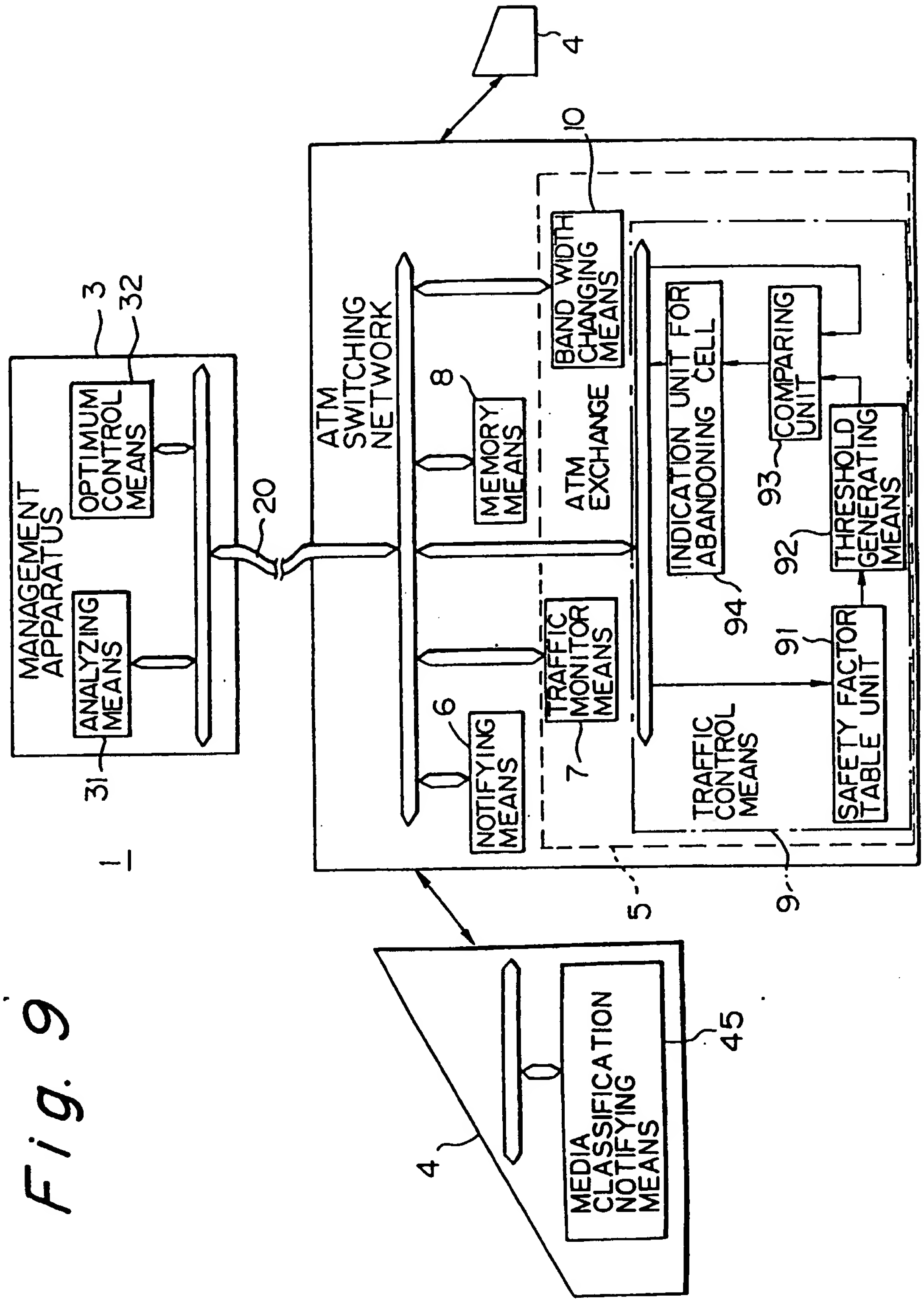

1
MANAGEMENT APPARATUS
3
32
OPTIMUM CONTROL MEANS
ANALYZING MEANS
31
20
ATM SWITCHING NETWORK
8
MEMORY MEANS
TRAFFIC MONITOR MEANS
7
6
NOTIFYING MEANS
BAND WIDTH CHANGING MEANS
10
ATM EXCHANGE
INDICATION UNIT FOR ABANDONING CELL
94
COMPARING UNIT
93
THRESHOLD GENERATING MEANS
92
SAFETY FACTOR TABLE UNIT
91
TRAFFIC CONTROL MEANS
5
9
4
MEDIA CLASSIFICATION NOTIFYING MEANS
45
4

Fig. 10

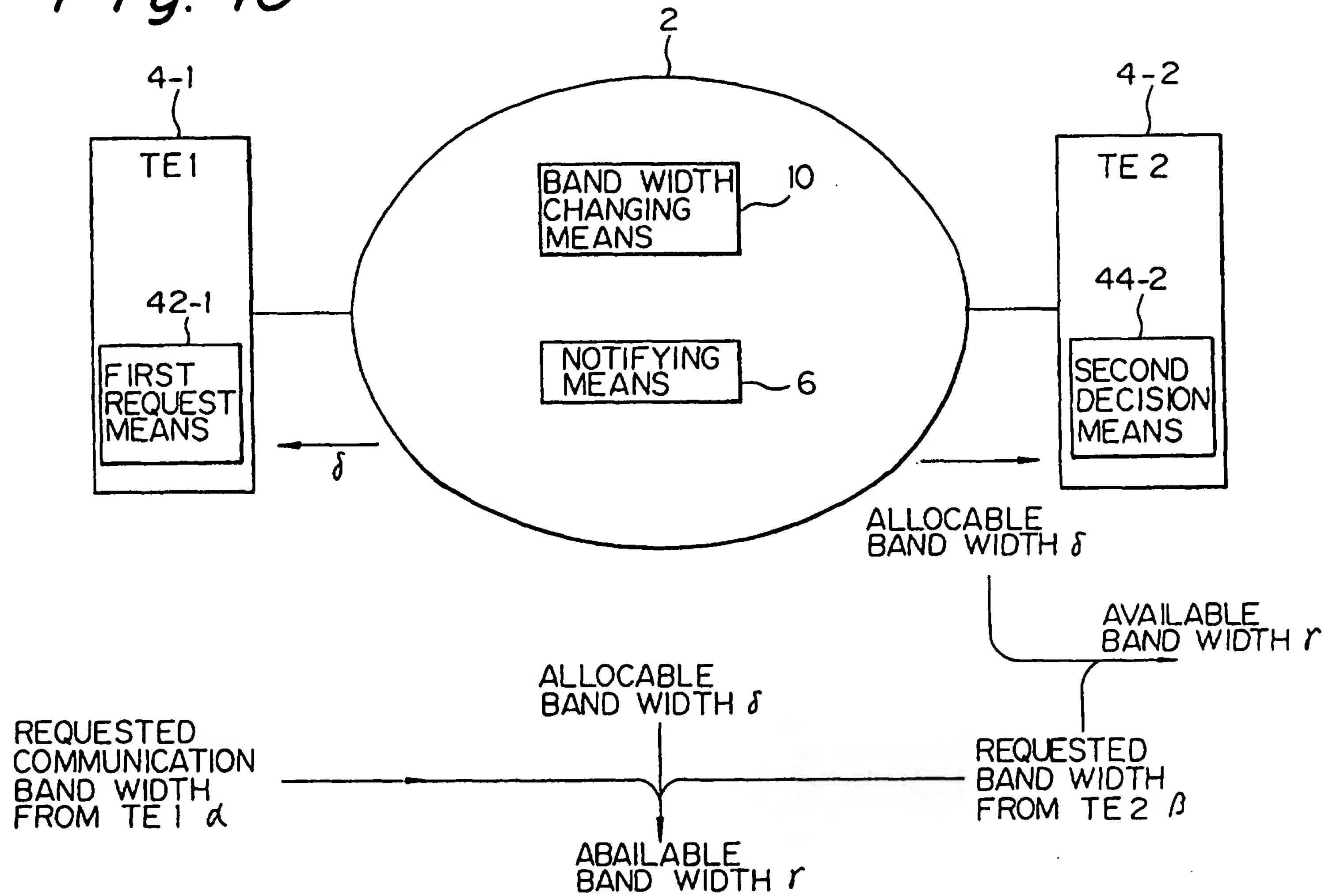
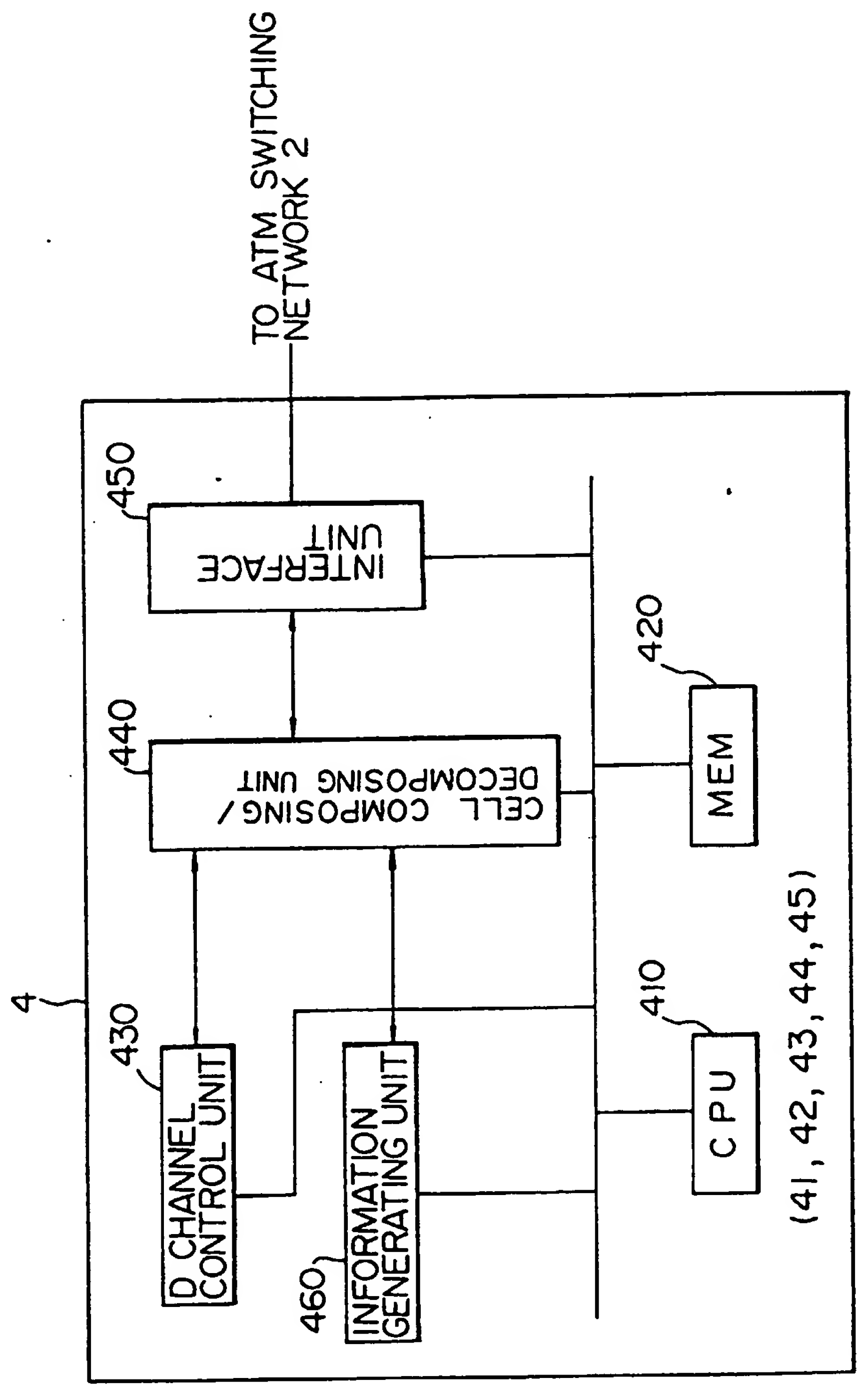

2
4-1
TE1
42-1
FIRST REQUEST MEANS
BAND WIDTH CHANGING MEANS
10
NOTIFYING MEANS
6
4-2
TE 2
44-2
SECOND DECISION MEANS
δ
ALLOCABLE BAND WIDTH δ
AVAILABLE BAND WIDTH r
REQUESTED BAND WIDTH FROM TE 2 β
REQUESTED COMMUNICATION BAND WIDTH FROM TE 1 α
ALLOCABLE BAND WIDTH δ
ABAILABLE BAND WIDTH r

Fig. 11


TO ATM SWITCHING NETWORK 2
4
450
INTERFACE UNIT
440
CELL COMPOSING / DECOMPOSING UNIT
420
MEM
430
D CHANNEL CONTROL UNIT
460
INFORMATION GENERATING UNIT
410
CPU
(41, 42, 43, 44, 45)

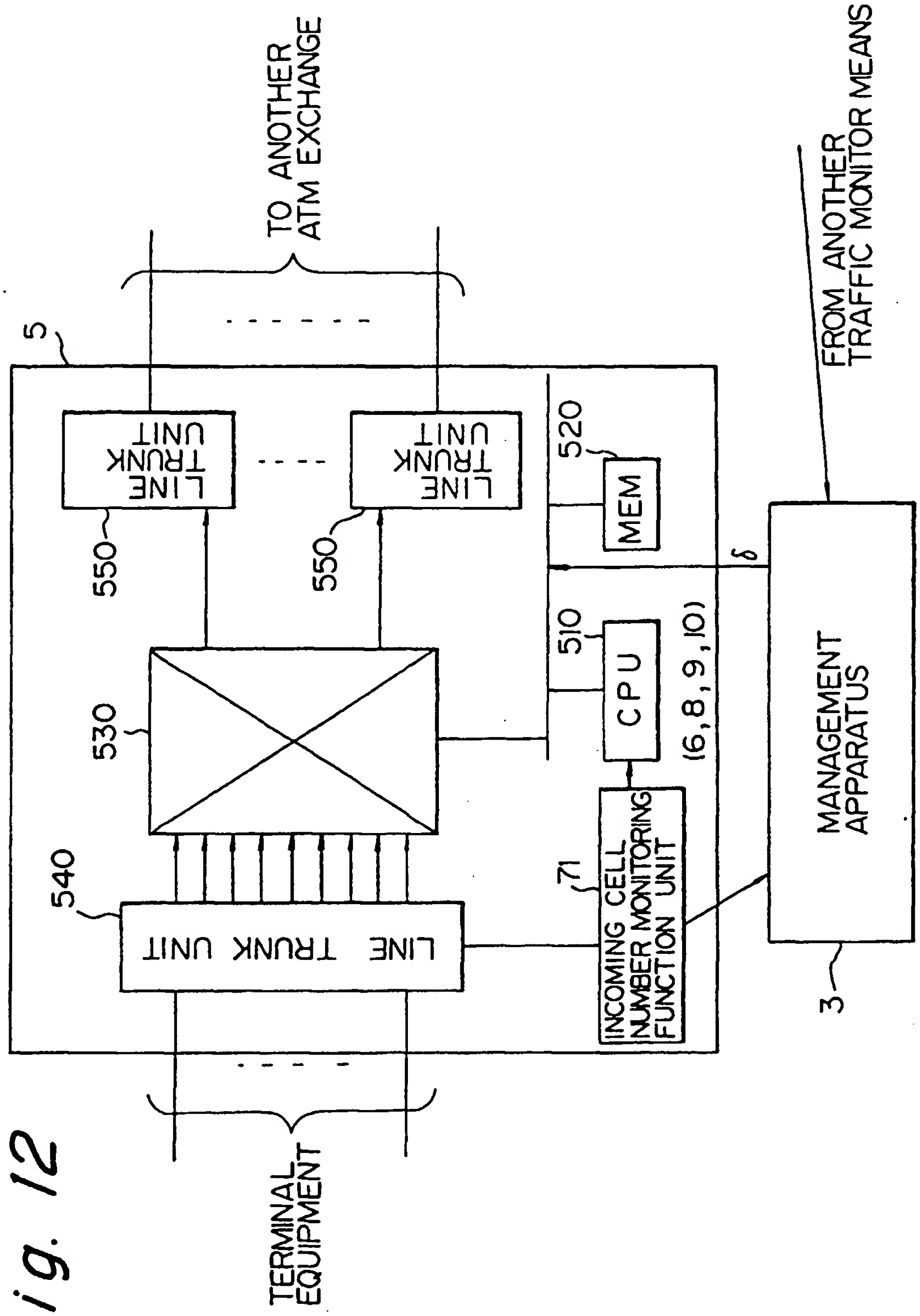

TO ANOTHER
ATM EXCHANGE
FROM ANOTHER
TRAFFIC MONITOR MEANS
5
LINE
TRUNK
UNIT
550
LINE
TRUNK
UNIT
550
520
MEM
510
CPU
(6, 8, 9, 10)
530
540
LINE TRUNK UNIT
71
INCOMING CELL
NUMBER MONITORING
FUNCTION UNIT
δ
MANAGEMENT
APPARATUS
3
TERMINAL
EQUIPMENT

Fig. 12

Fig. 13A

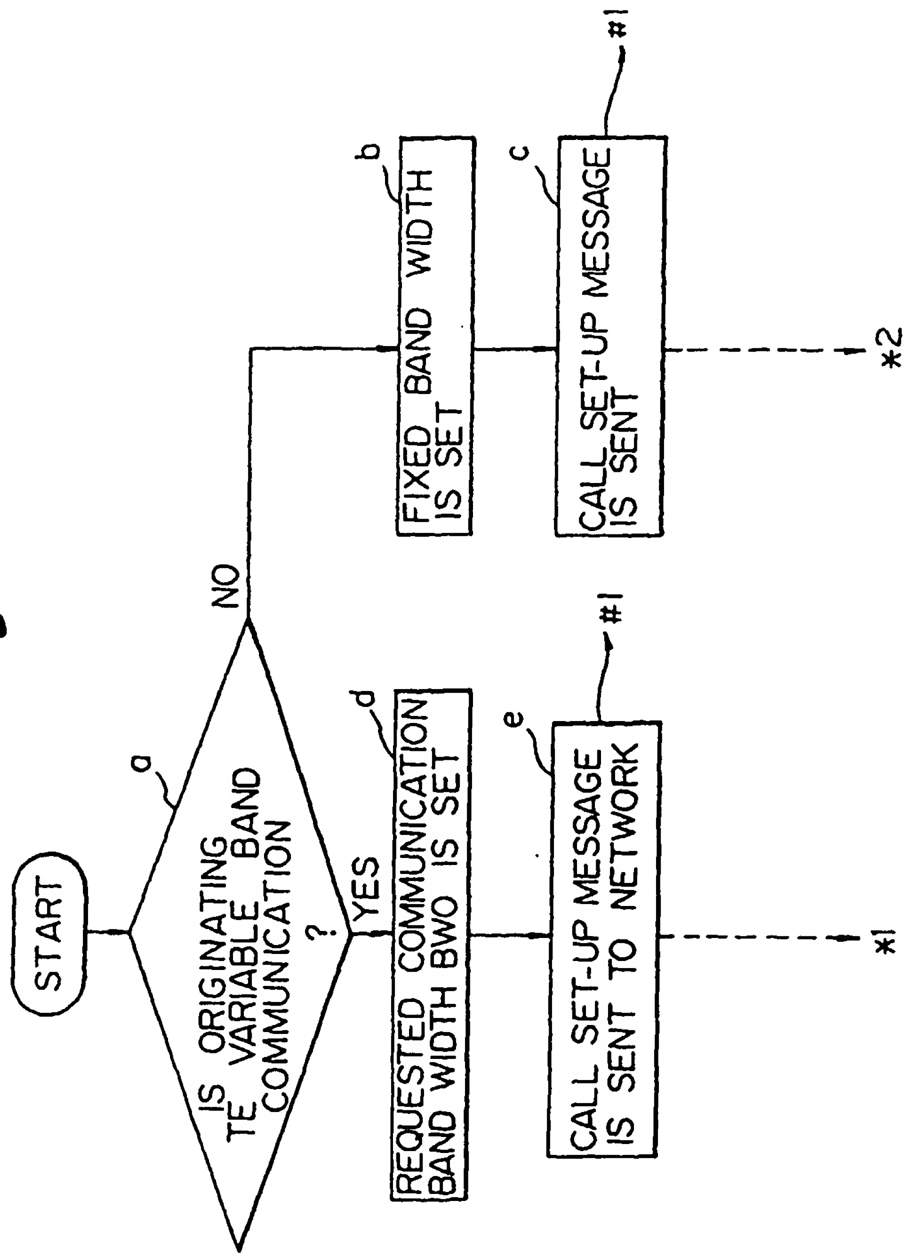

START
a
IS ORIGINATING TE VARIABLE BAND COMMUNICATION ?
YES
NO
d
REQUESTED COMMUNICATION BAND WIDTH BWO IS SET
e
CALL SET-UP MESSAGE IS SENT TO NETWORK
#1
*1
b
FIXED BAND WIDTH IS SET
c
CALL SET-UP MESSAGE IS SENT
#1
*2

Fig. 13B

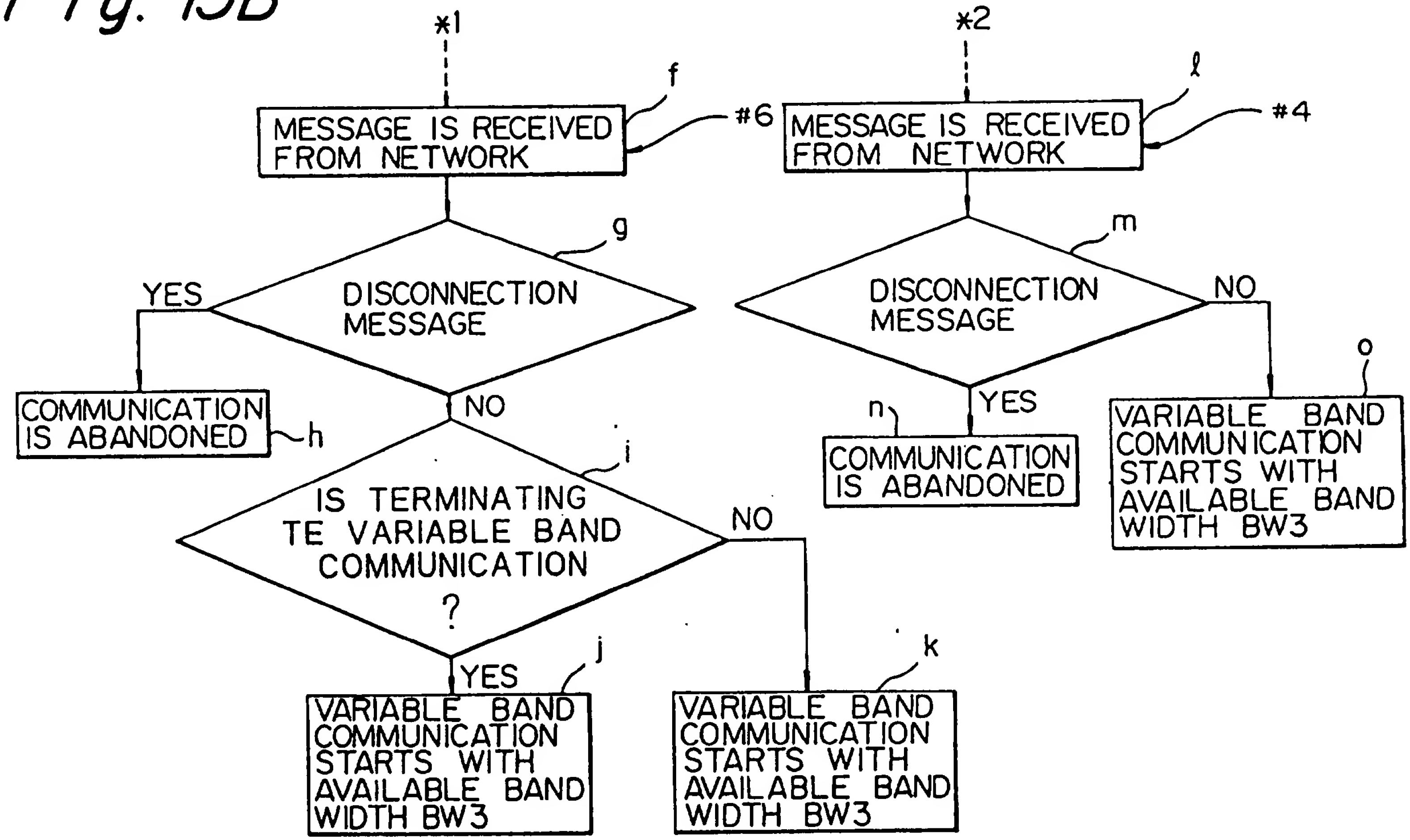

*1
*2
f
ℓ
#6
#4
MESSAGE IS RECEIVED FROM NETWORK
MESSAGE IS RECEIVED FROM NETWORK
g
m
DISCONNECTION MESSAGE
DISCONNECTION MESSAGE
YES
NO
YES
NO
COMMUNICATION IS ABANDONED
h
n
COMMUNICATION IS ABANDONED
o
VARIABLE BAND COMMUNICATION STARTS WITH AVAILABLE BAND WIDTH BW3
i
IS TERMINATING TE VARIABLE BAND COMMUNICATION ?
NO
YES
j
k
VARIABLE BAND COMMUNICATION STARTS WITH AVAILABLE BAND WIDTH BW3
VARIABLE BAND COMMUNICATION STARTS WITH AVAILABLE BAND WIDTH BW3

Fig. 14A

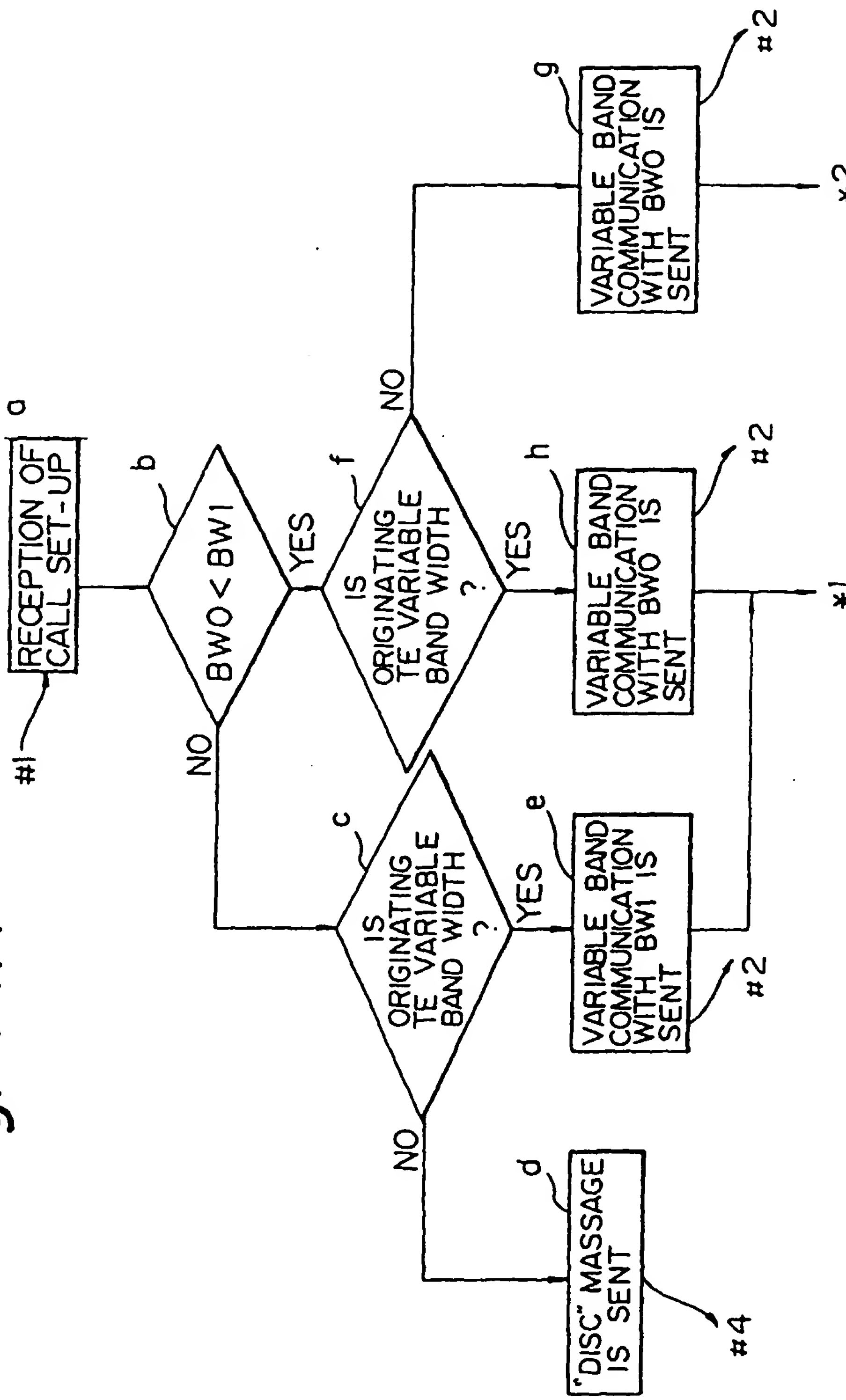
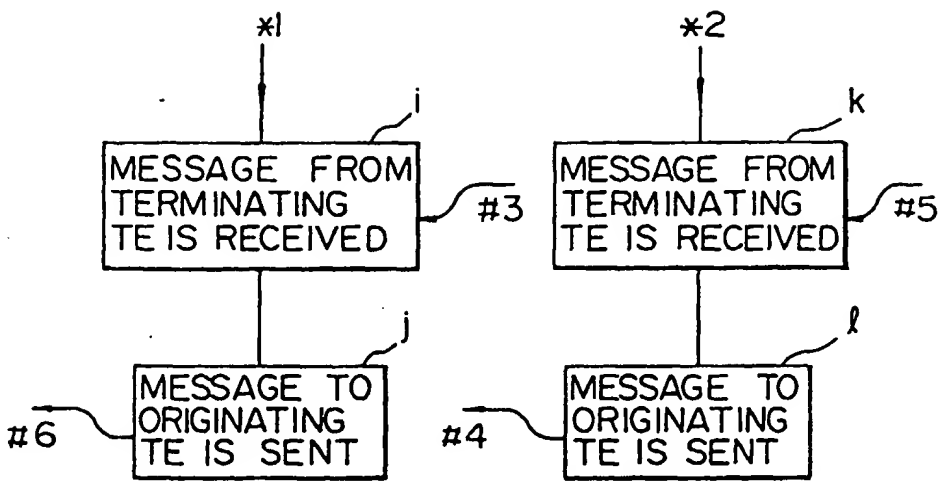

RECEPTION OF CALL SET-UP
a
#1
b
BWO < BW1
YES
NO
f
IS ORIGINATING TE VARIABLE BAND WIDTH ?
c
IS ORIGINATING TE VARIABLE BAND WIDTH ?
YES
NO
g
VARIABLE BAND COMMUNICATION WITH BWO IS SENT
#2
*2
h
VARIABLE BAND COMMUNICATION WITH BWO IS SENT
#2
*1
e
VARIABLE BAND COMMUNICATION WITH BW1 IS SENT
#2
d
"DISC" MASSAGE IS SENT
#4

Fig. 14B


*1
*2
i
k
MESSAGE FROM TERMINATING TE IS RECEIVED
#3
MESSAGE FROM TERMINATING TE IS RECEIVED
#5
j
ℓ
MESSAGE TO ORIGINATING TE IS SENT
#6
MESSAGE TO ORIGINATING TE IS SENT
#4

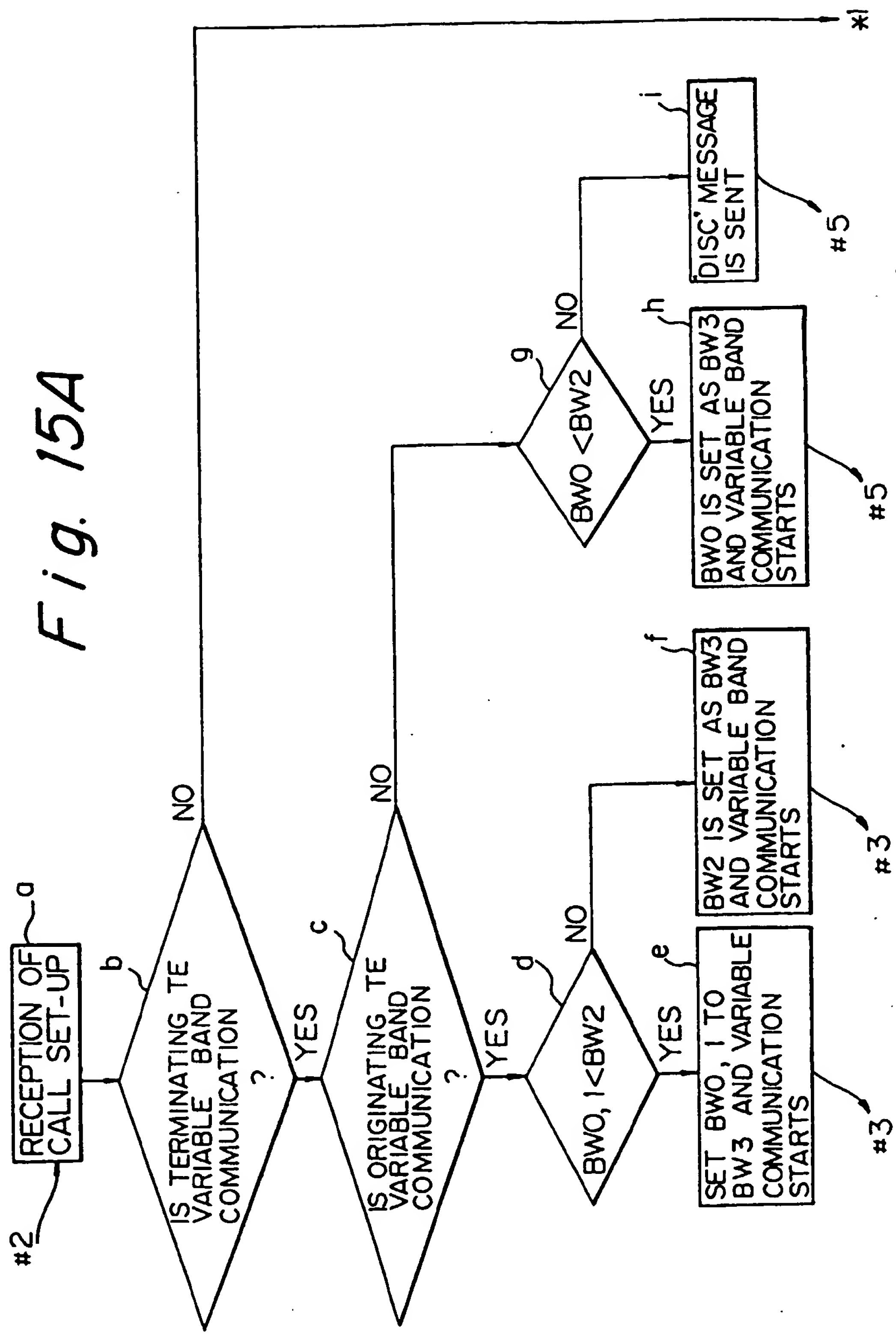
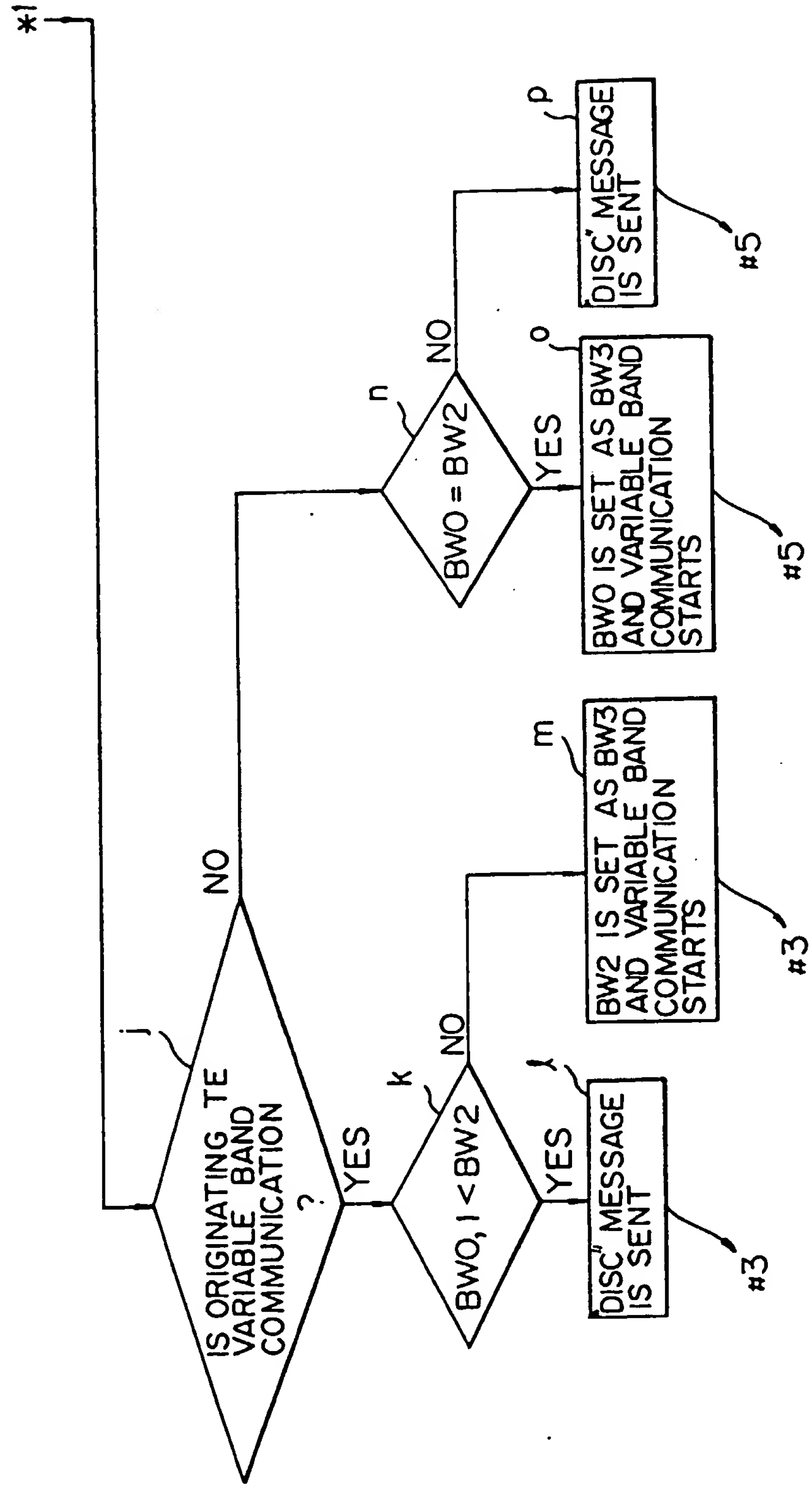

RECEPTION OF CALL SET-UP
#2
a
b
IS TERMINATING TE VARIABLE BAND COMMUNICATION ?
YES
NO
c
IS ORIGINATING TE VARIABLE BAND COMMUNICATION ?
YES
NO
d
BWO, I<BW2
YES
NO
e
SET BWO, I TO BW3 AND VARIABLE COMMUNICATION STARTS
#3
f
BW2 IS SET AS BW3 AND VARIABLE BAND COMMUNICATION STARTS
#3
g
BWO <BW2
YES
NO
h
BWO IS SET AS BW3 AND VARIABLE BAND COMMUNICATION STARTS
#5
i
DISC' MESSAGE IS SENT
#5
*I

Fig. 15A

Fig. 15B



*1
IS ORIGINATING TE VARIABLE BAND COMMUNICATION ?
j
YES
NO
BWO, I <BW2
k
YES
NO
DISC' MESSAGE IS SENT
l
#3
BW2 IS SET AS BW3 AND VARIABLE BAND COMMUNICATION STARTS
m
#3
BWO = BW2
n
YES
NO
BWO IS SET AS BW3 AND VARIABLE BAND COMMUNICATION STARTS
o
#5
DISC' MESSAGE IS SENT
p
#5

Fig.16A

Fig. 16A-1	Fig. 16A-2

Fig. 16A-1

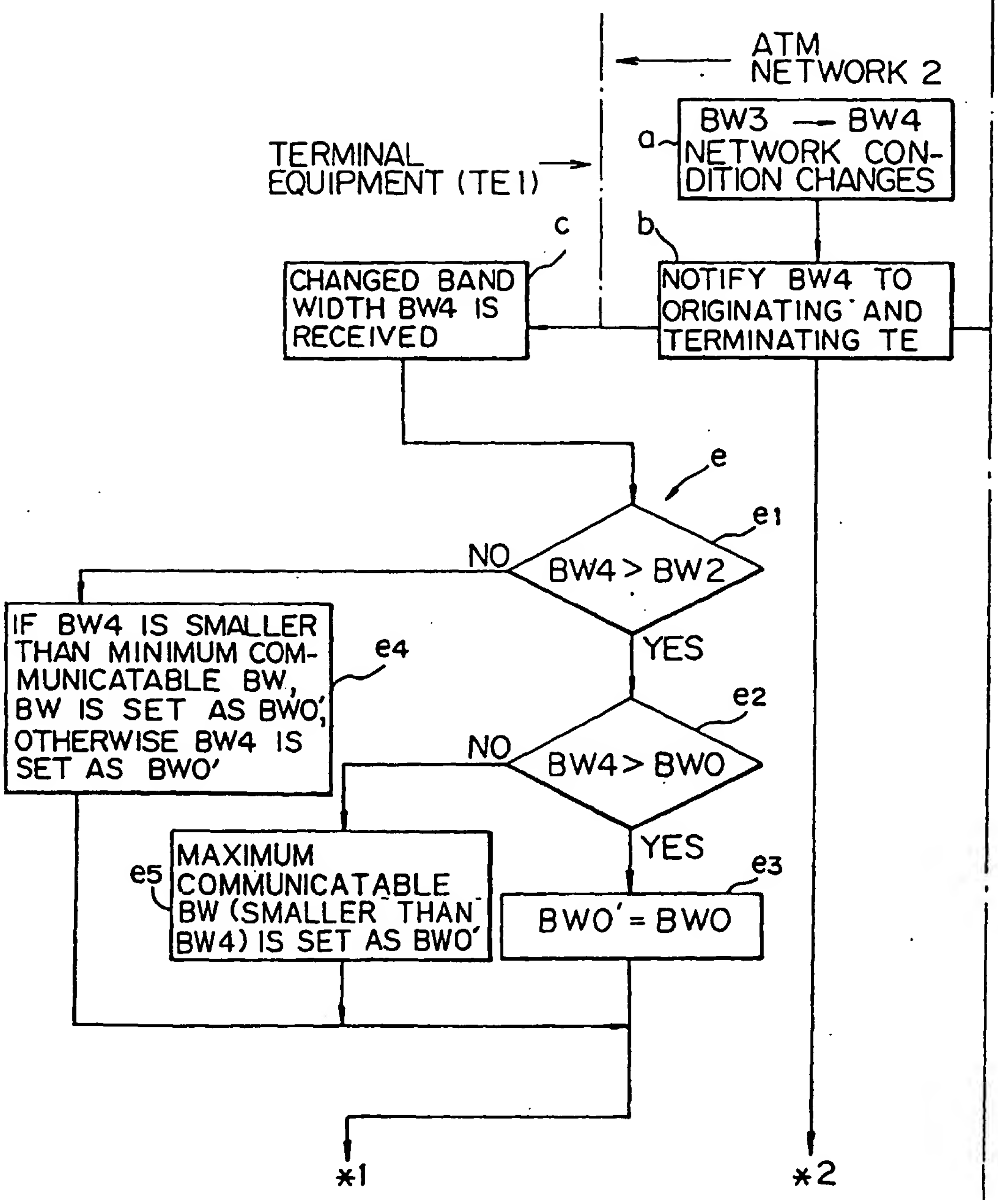


Fig. 16A-2

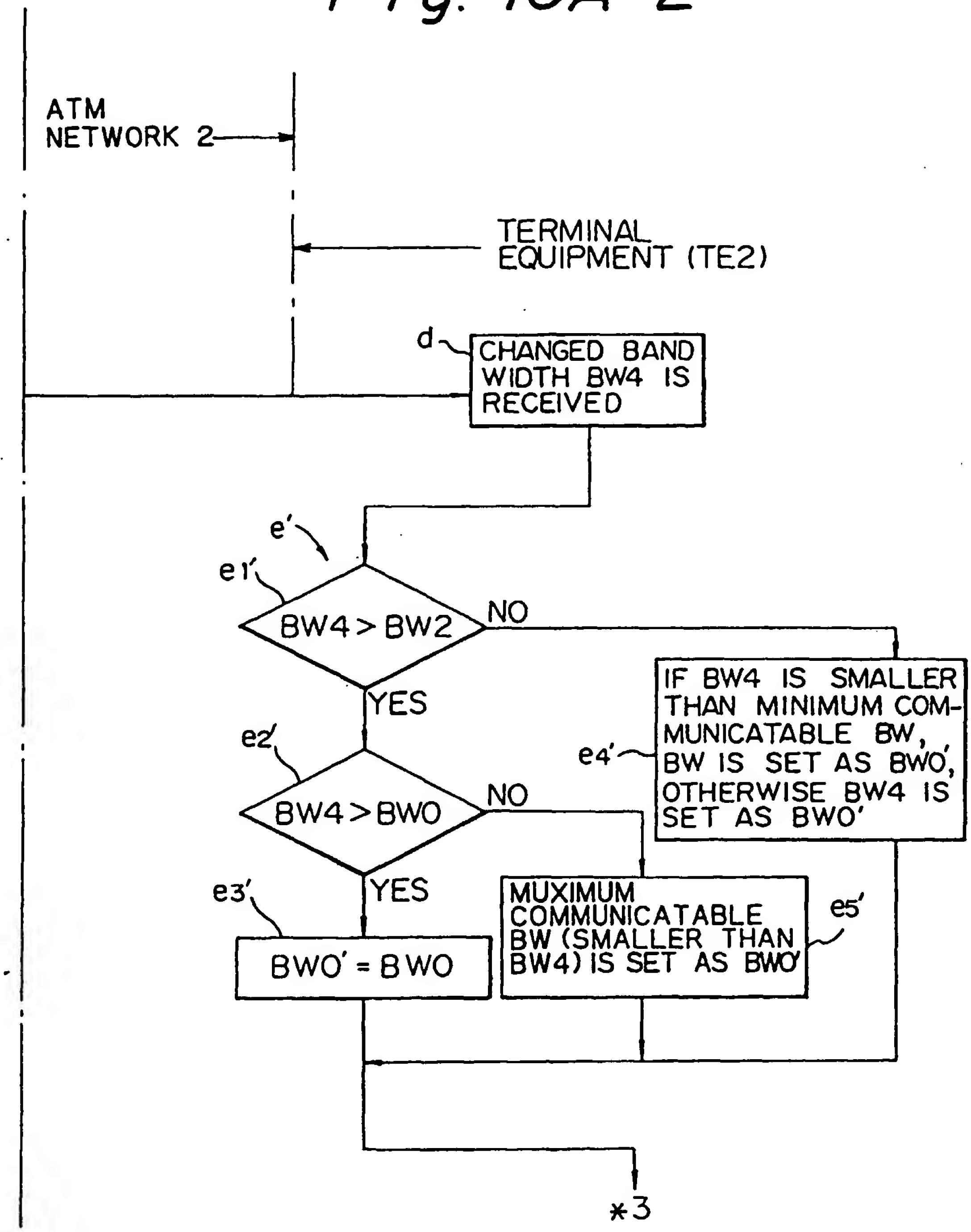

ATM NETWORK 2
TERMINAL EQUIPMENT (TE2)
d
CHANGED BAND WIDTH BW4 IS RECEIVED
e'
e1'
BW4 > BW2
NO
YES
IF BW4 IS SMALLER THAN MINIMUM COM-MUNICATABLE BW, BW IS SET AS BWO', OTHERWISE BW4 IS SET AS BWO'
e4'
e2'
BW4 > BWO
NO
YES
e3'
BWO' = BWO
MUXIMUM COMMUNICATABLE BW (SMALLER THAN BW4) IS SET AS BWO'
e5'
*3

Fig. 16B

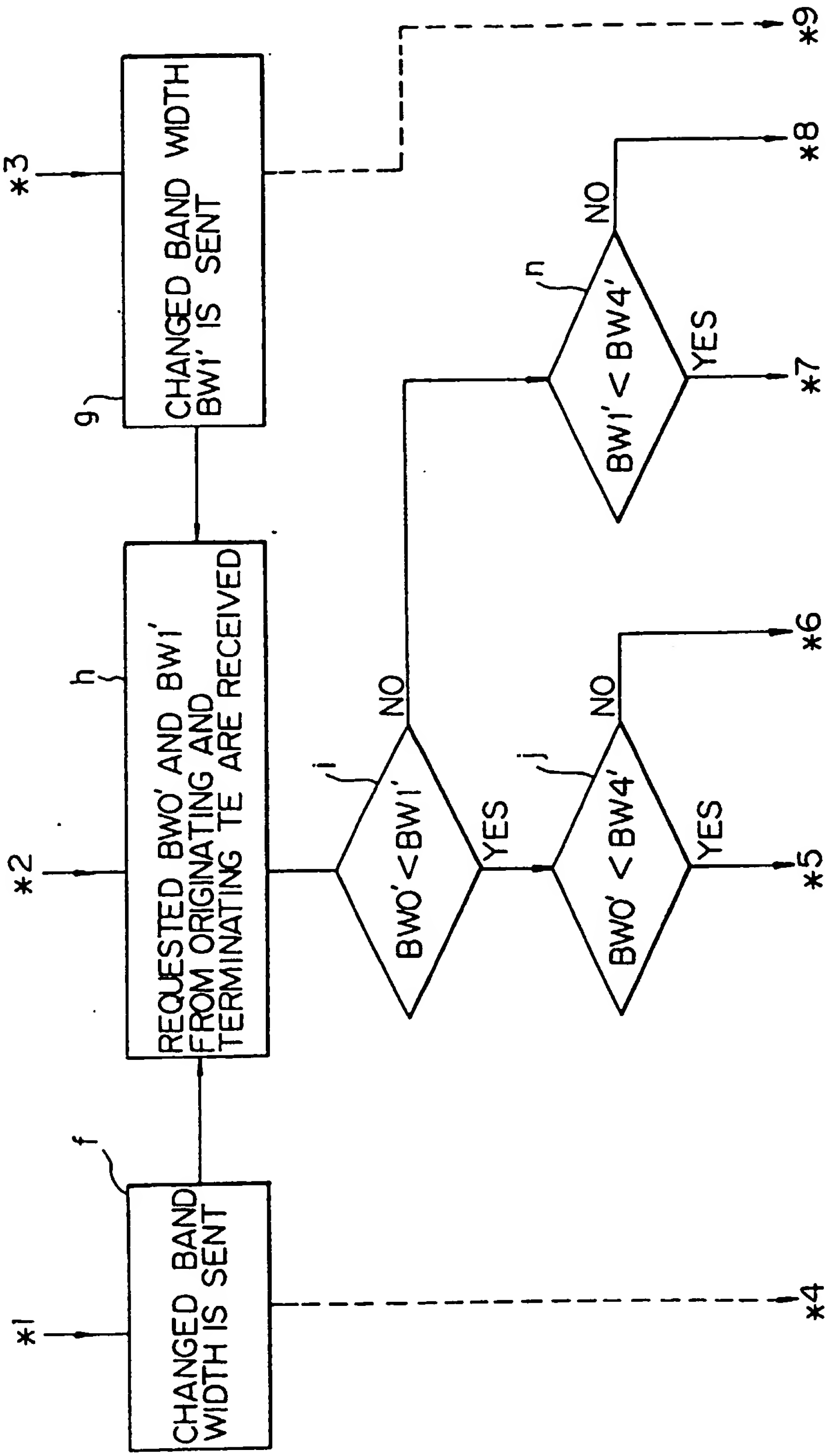

*1
CHANGED BAND WIDTH IS SENT
f
*4
*2
REQUESTED BWO' AND BW1' FROM ORIGINATING AND TERMINATING TE ARE RECEIVED
h
*3
CHANGED BAND WIDTH BW1' IS SENT
g
*9
i
BWO'<BW1'
YES
NO
j
BWO' < BW4'
YES
NO
*5
*6
n
BW1' < BW4'
YES
NO
*7
*8

Fig. 16C

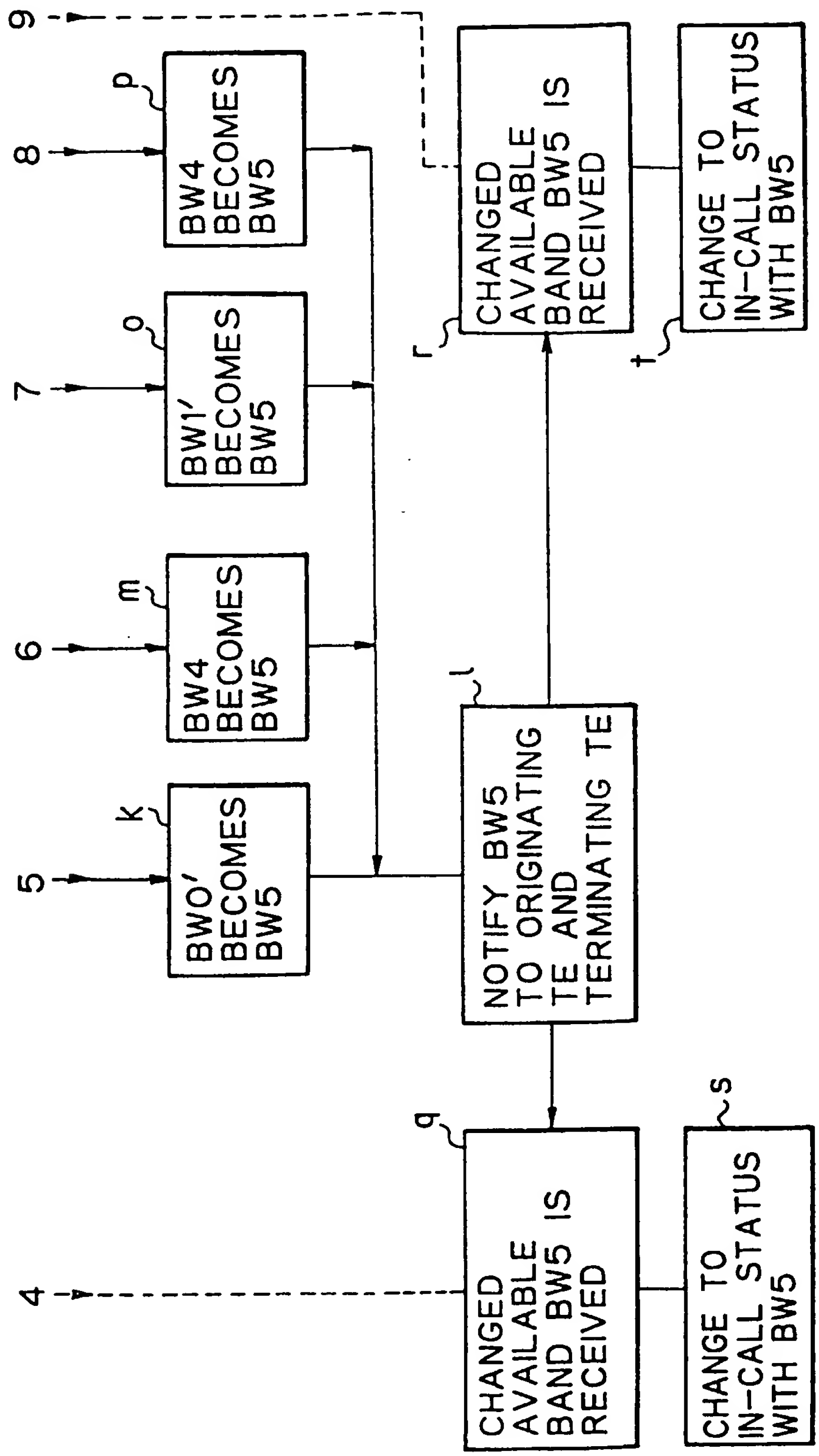
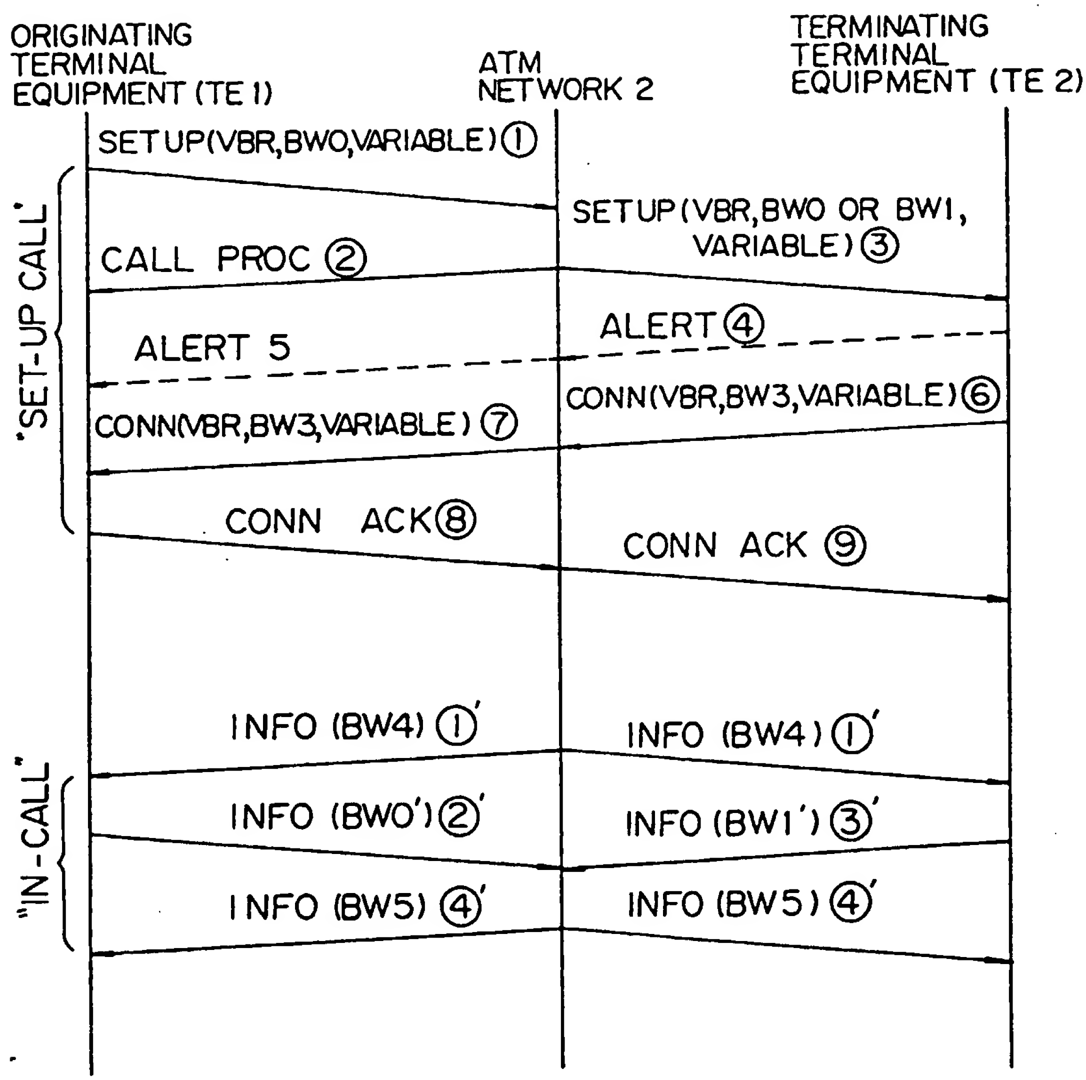

BWO' BECOMES BW5
BW4 BECOMES BW5
BW1' BECOMES BW5
BW4 BECOMES BW5
NOTIFY BW5 TO ORIGINATING TE AND TERMINATING TE
CHANGED AVAILABLE BAND BW5 IS RECEIVED
CHANGE TO IN-CALL STATUS WITH BW5
CHANGED AVAILABLE BAND BW5 IS RECEIVED
CHANGE TO IN-CALL STATUS WITH BW5
4
5
6
7
8
9
k
m
o
p
l
q
r
s
t

Fig. 17


ORIGINATING TERMINAL EQUIPMENT (TE 1)
ATM NETWORK 2
TERMINATING TERMINAL EQUIPMENT (TE 2)
SETUP(VBR,BW0,VARIABLE) ①
SETUP (VBR, BW0 OR BW1, VARIABLE) ③
CALL PROC ②
ALERT ④
ALERT 5
CONN(VBR,BW3,VARIABLE) ⑥
CONN(VBR,BW3,VARIABLE) ⑦
CONN ACK ⑧
CONN ACK ⑨
"SET-UP CALL"
INFO (BW4) ①'
INFO (BW4) ①'
INFO (BW0') ②'
INFO (BW1') ③'
INFO (BW5) ④'
INFO (BW5) ④'
"IN-CALL"

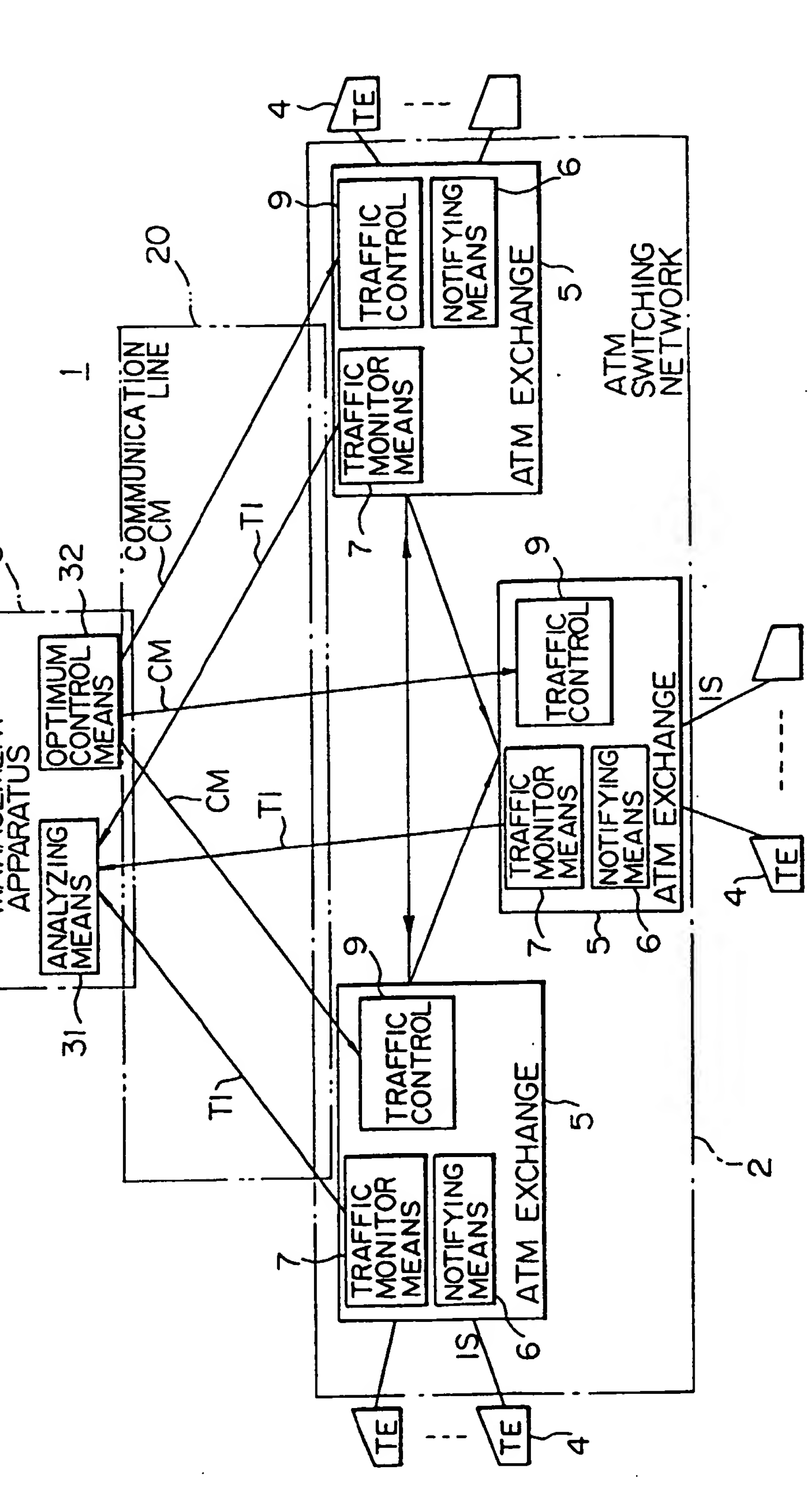

MANAGEMENT APPARATUS
ANALYZING MEANS
OPTIMUM CONTROL MEANS
COMMUNICATION LINE
ATM SWITCHING NETWORK
ATM EXCHANGE
TRAFFIC CONTROL
TRAFFIC MONITOR MEANS
NOTIFYING MEANS
TE
CM
TI
IS
1
2
3
4
5
6
7
9
20
31
32

Fig. 18

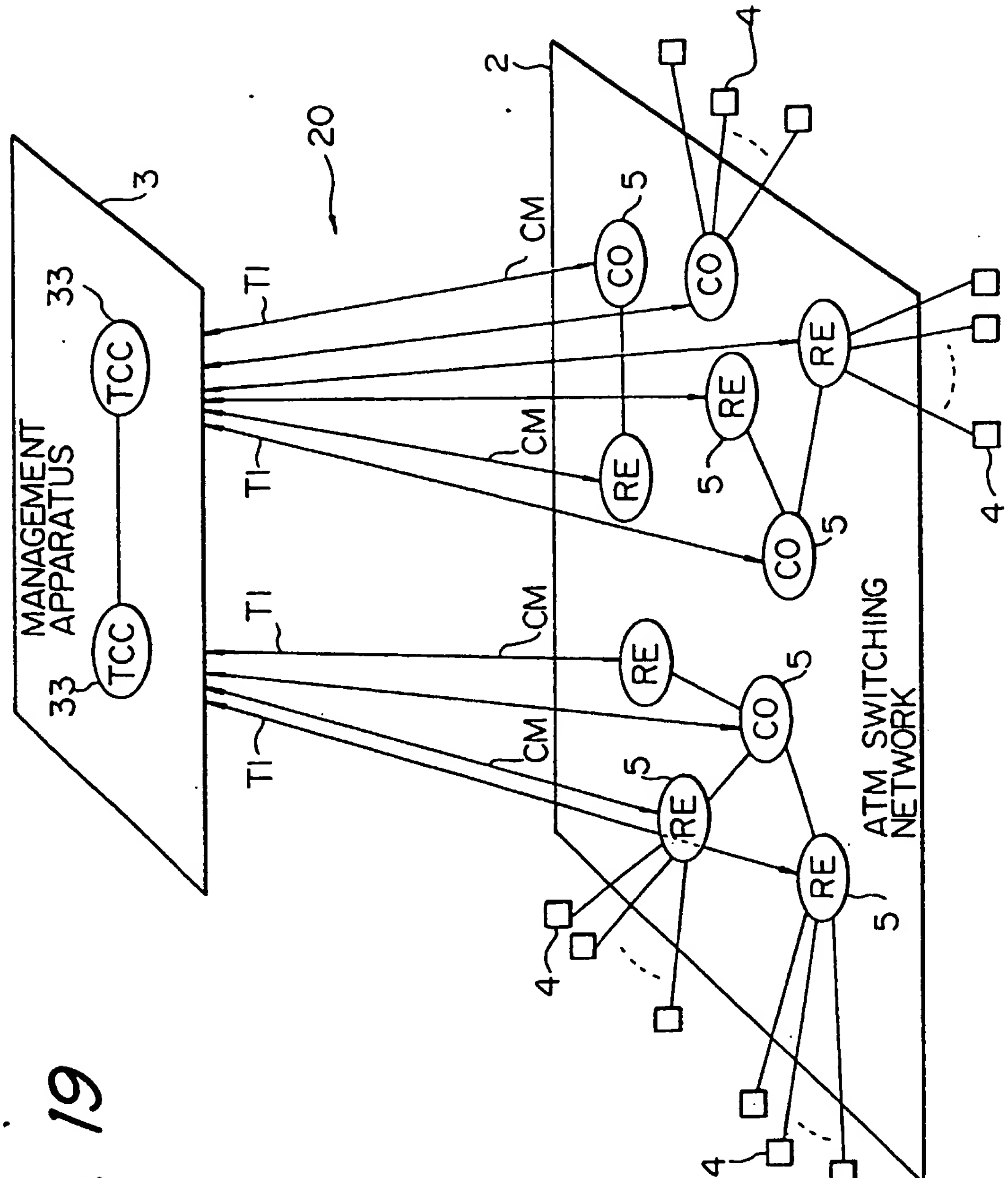

MANAGEMENT APPARATUS
TCC
TCC
33
33
3
20
2
TI
TI
TI
TI
CM
CM
CM
CM
CO
CO
CO
CO
RE
RE
RE
RE
RE
RE
5
4
ATM SWITCHING NETWORK

Fig. 19

Fig. 20

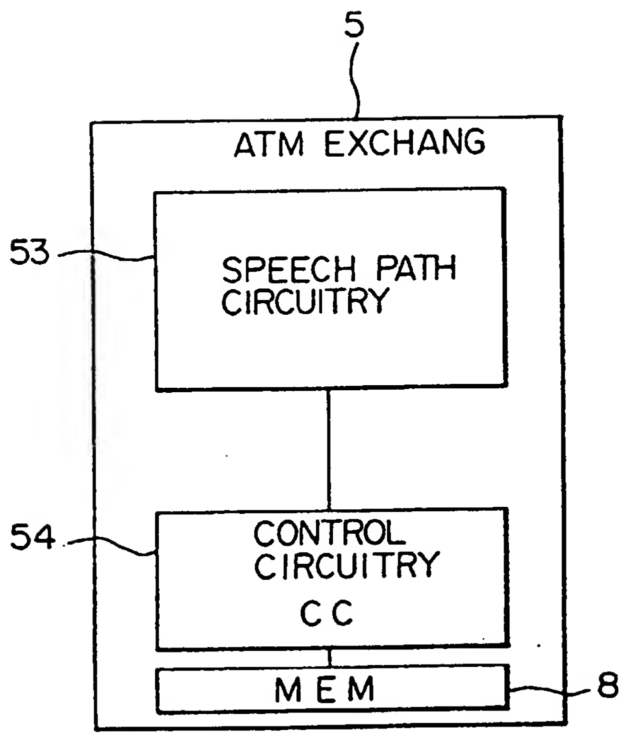

5
ATM EXCHANG
53
SPEECH PATH
CIRCUITRY
54
CONTROL
CIRCUITRY
CC
MEM
8

Fig. 21A

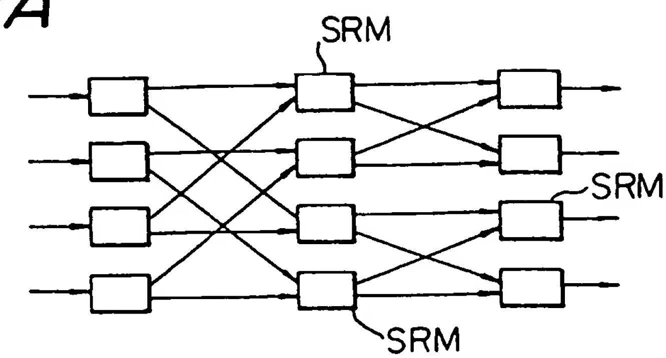


Fig. 21B

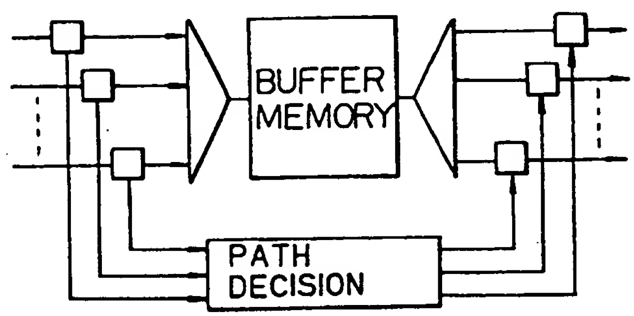
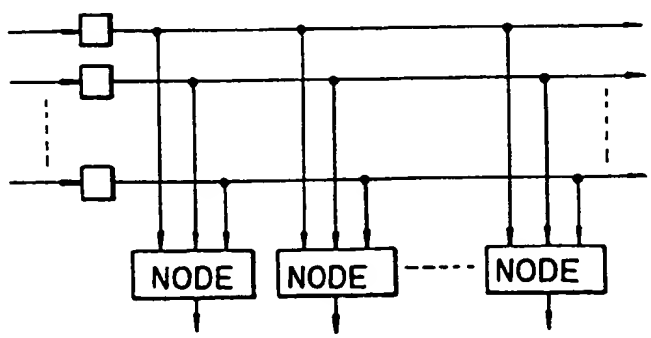


Fig. 21C



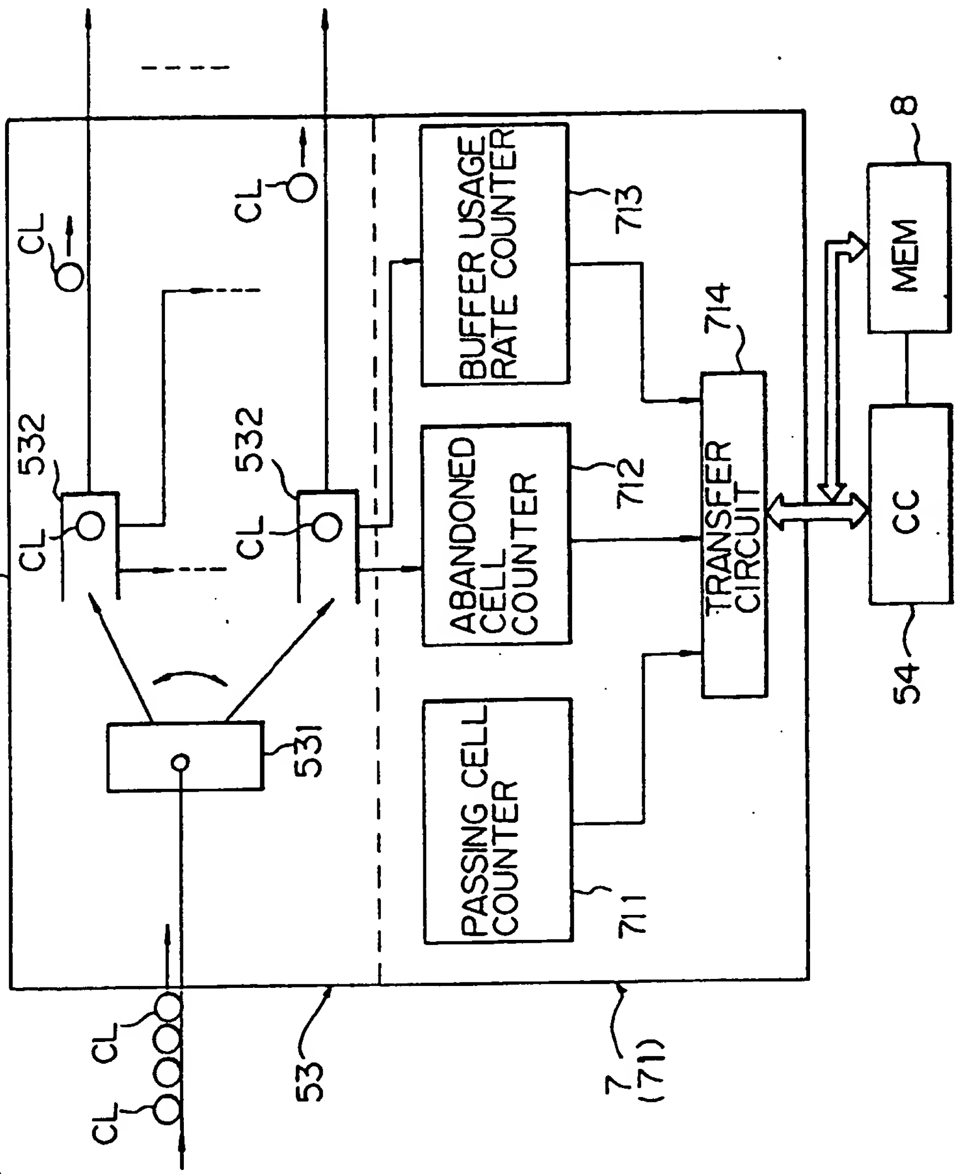

5
53
7
(71)
CL
CL
CL
531
532
CL
532
CL
CL
CL
PASSING CELL COUNTER
711
ABANDONED CELL COUNTER
712
BUFFER USAGE RATE COUNTER
713
TRANSFER CIRCUIT
714
CC
54
MEM
8

Fig. 22

Fig. 23

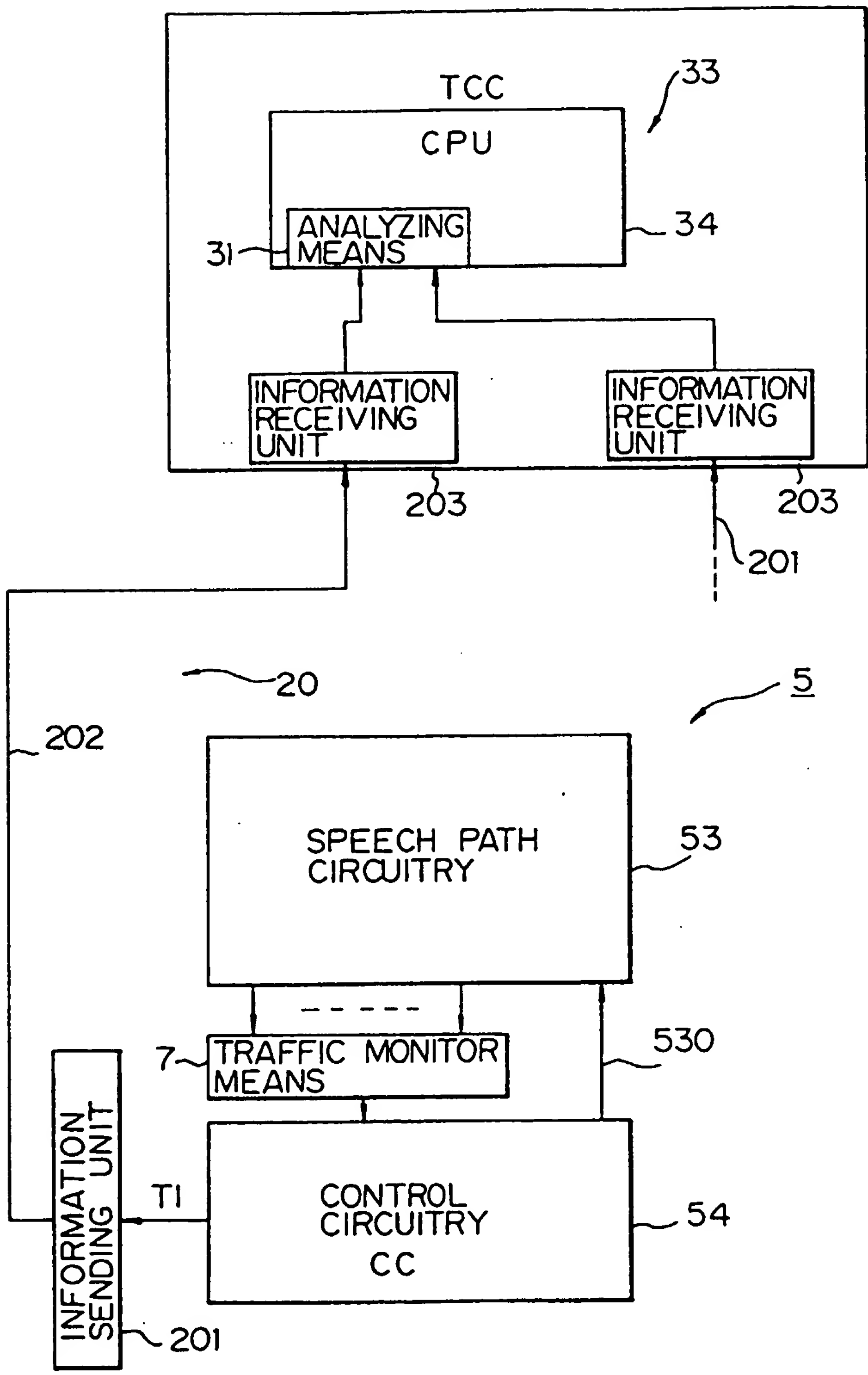

TCC
33
CPU
3
ANALYZING MEANS
31
34
INFORMATION RECEIVING UNIT
INFORMATION RECEIVING UNIT
203
203
201
20
5
202
SPEECH PATH CIRCUITRY
53
530
7
TRAFFIC MONITOR MEANS
INFORMATION SENDING UNIT
TI
CONTROL CIRCUITRY
CC
54
201

Fig. 24

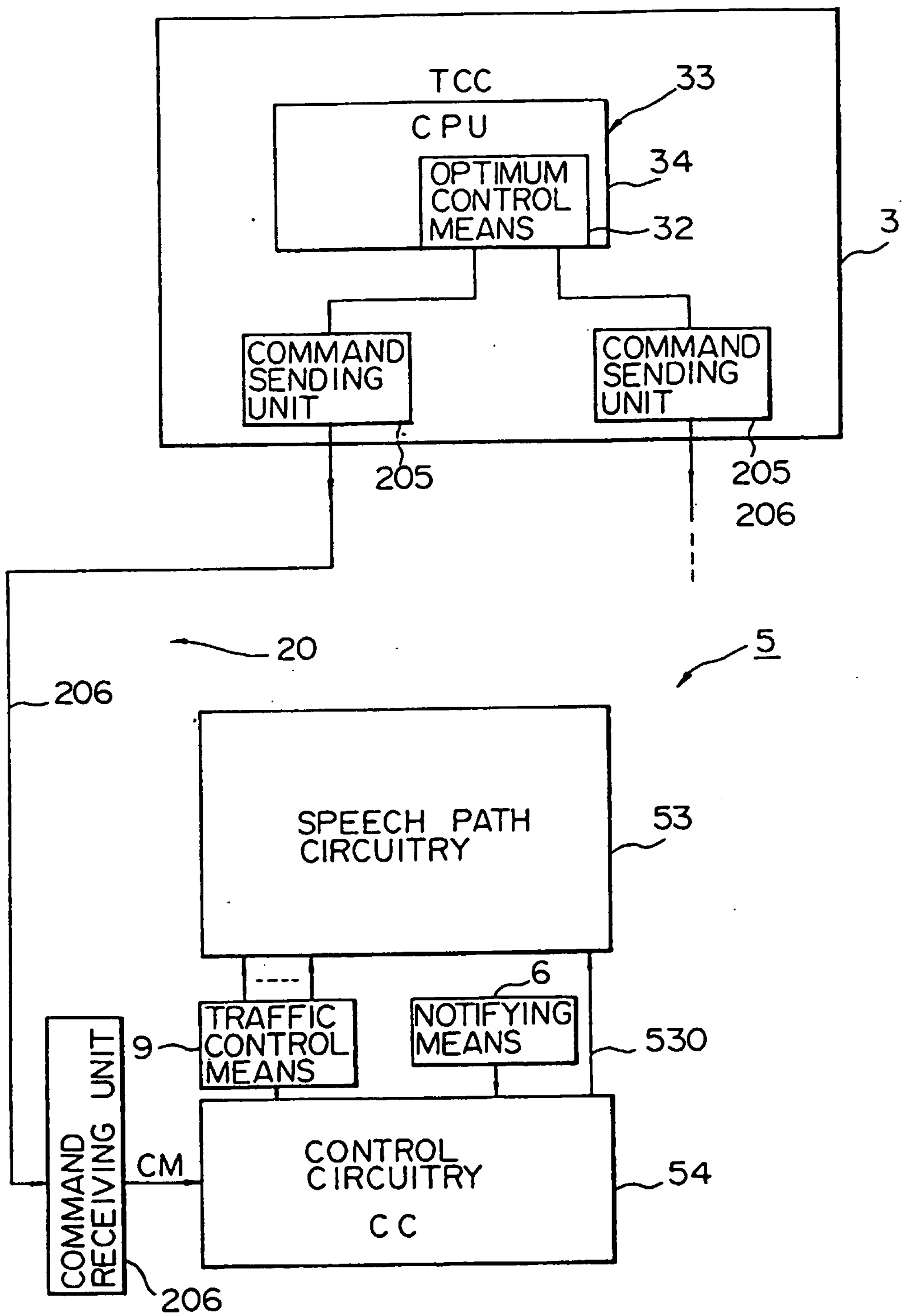
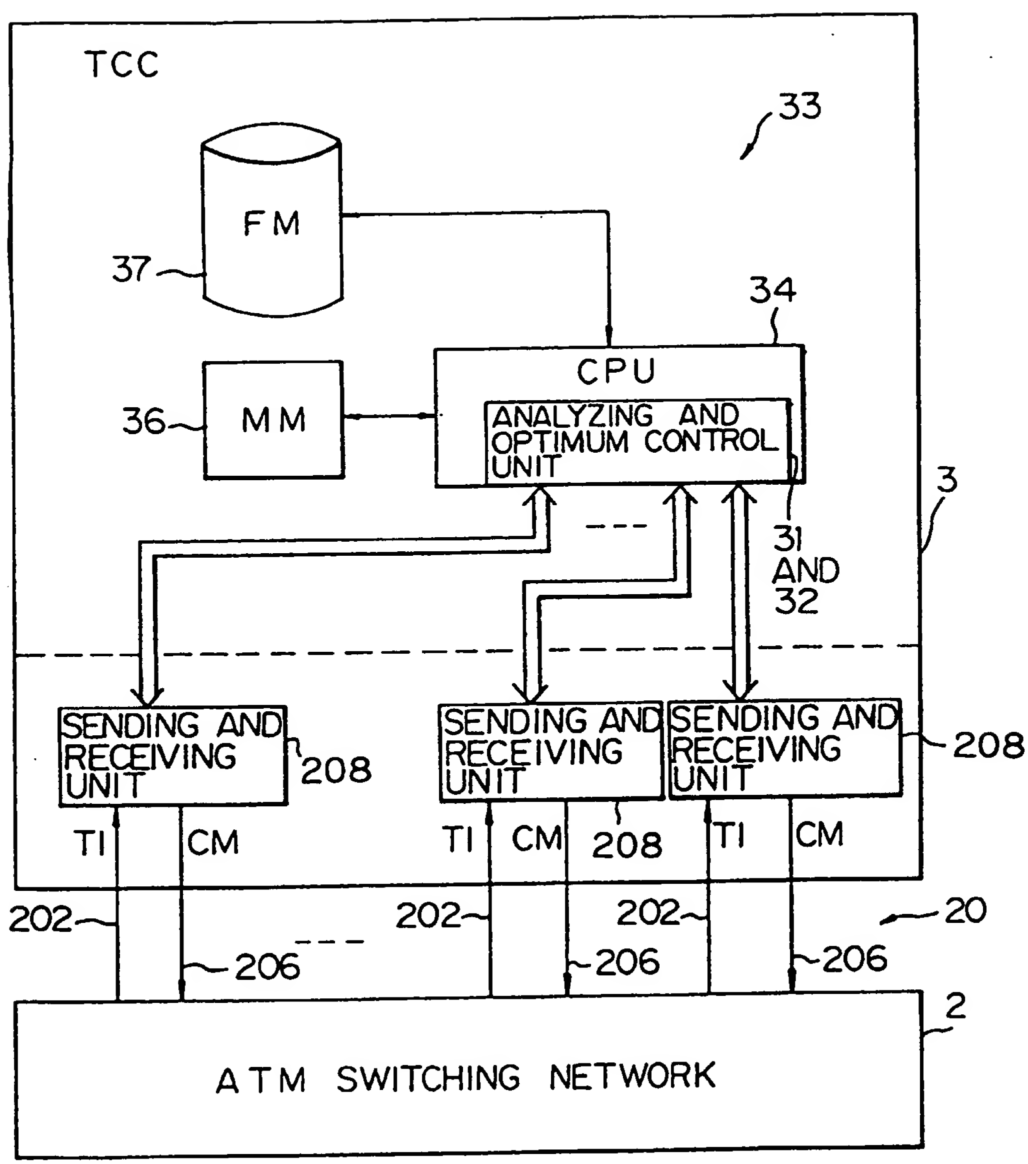

TCC
33
CPU
34
OPTIMUM CONTROL MEANS
32
3
COMMAND SENDING UNIT
COMMAND SENDING UNIT
205
205
206
20
5
206
SPEECH PATH CIRCUITRY
53
6
TRAFFIC CONTROL MEANS
NOTIFYING MEANS
530
9
COMMAND RECEIVING UNIT
CM
CONTROL CIRCUITRY
CC
54
206

Fig. 25


TCC
33
FM
37
34
CPU
36
MM
ANALYZING AND OPTIMUM CONTROL UNIT
31 AND 32
3
SENDING AND RECEIVING UNIT
208
SENDING AND RECEIVING UNIT
SENDING AND RECEIVING UNIT
208
TI
CM
TI
CM
208
TI
CM
202
206
202
206
202
20
206
2
ATM SWITCHING NETWORK

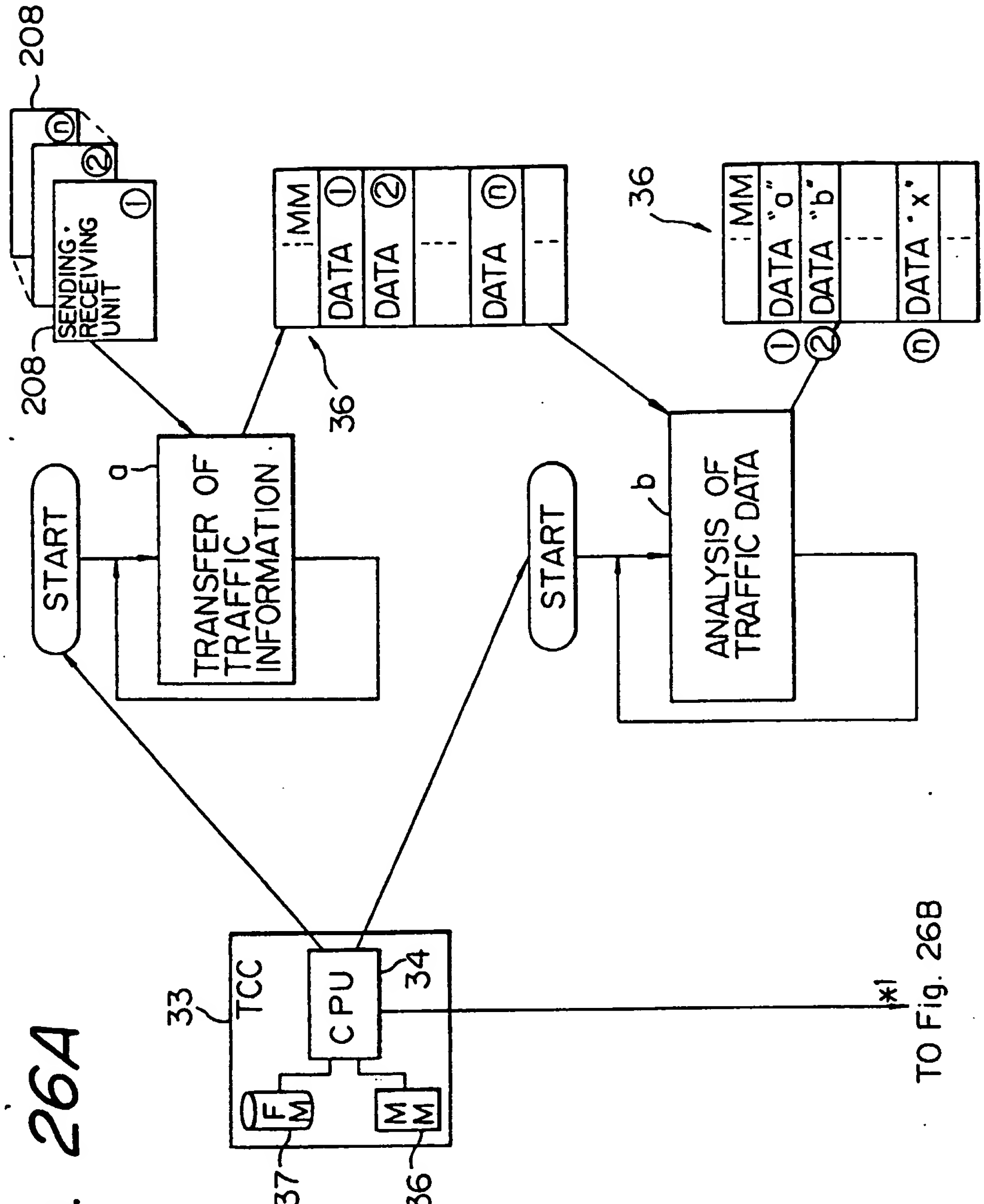

208
SENDING·RECEIVING UNIT
208
MM
DATA
DATA
DATA
36
START
a
TRANSFER OF TRAFFIC INFORMATION
START
b
ANALYSIS OF TRAFFIC DATA
36
MM
DATA "a"
DATA "b"
DATA "x"
TCC
33
CPU
34
FM
37
MM
36
*1
TO Fig. 26B

Fig. 26A

Fig. 26B

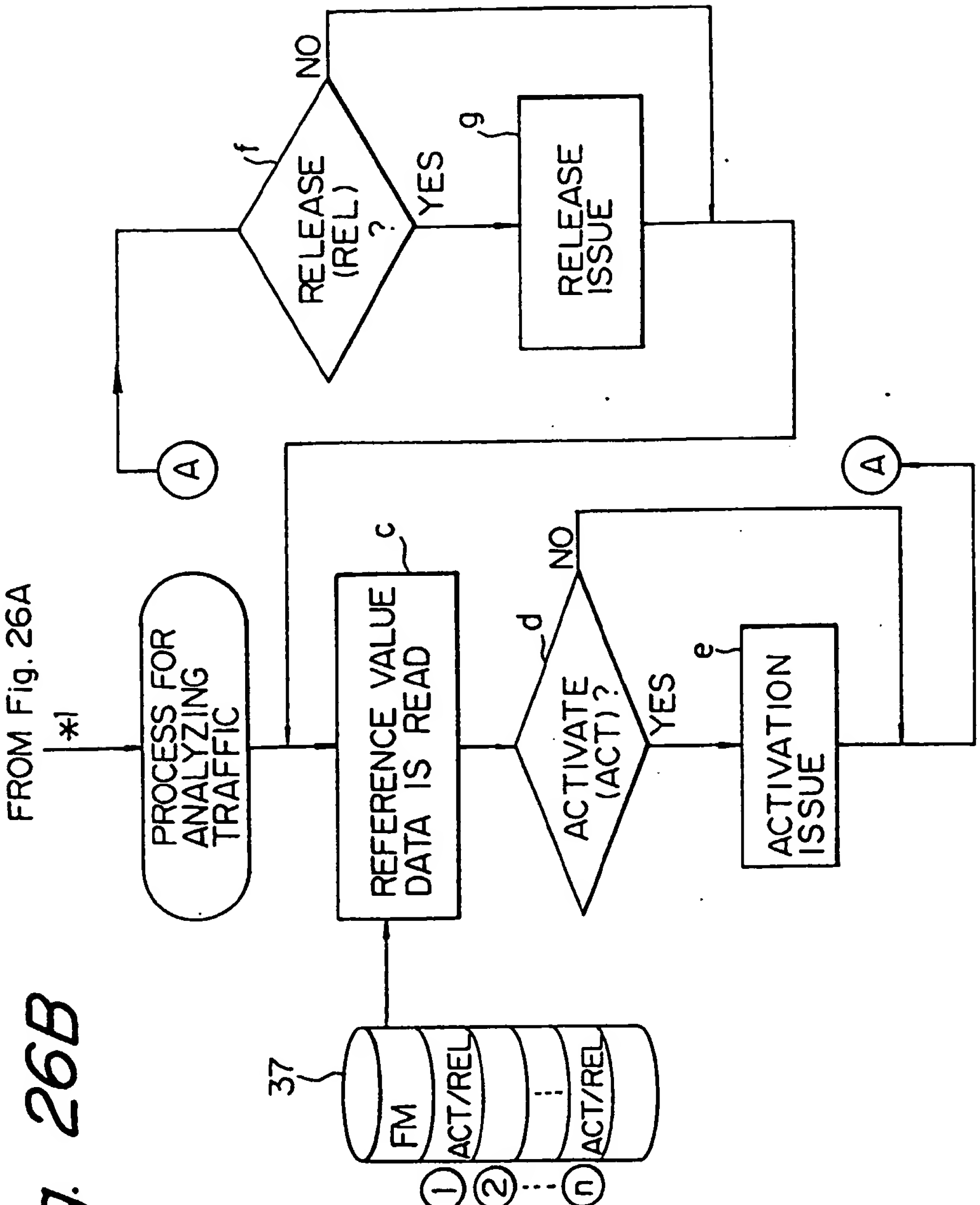

FROM Fig. 26A
*1
PROCESS FOR ANALYZING TRAFFIC
REFERENCE VALUE DATA IS READ
c
37
FM
ACT/REL
ACT/REL
1
2
n
d
ACTIVATE (ACT) ?
YES
NO
e
ACTIVATION ISSUE
A
A
f
RELEASE (REL) ?
YES
NO
g
RELEASE ISSUE

Fig. 27

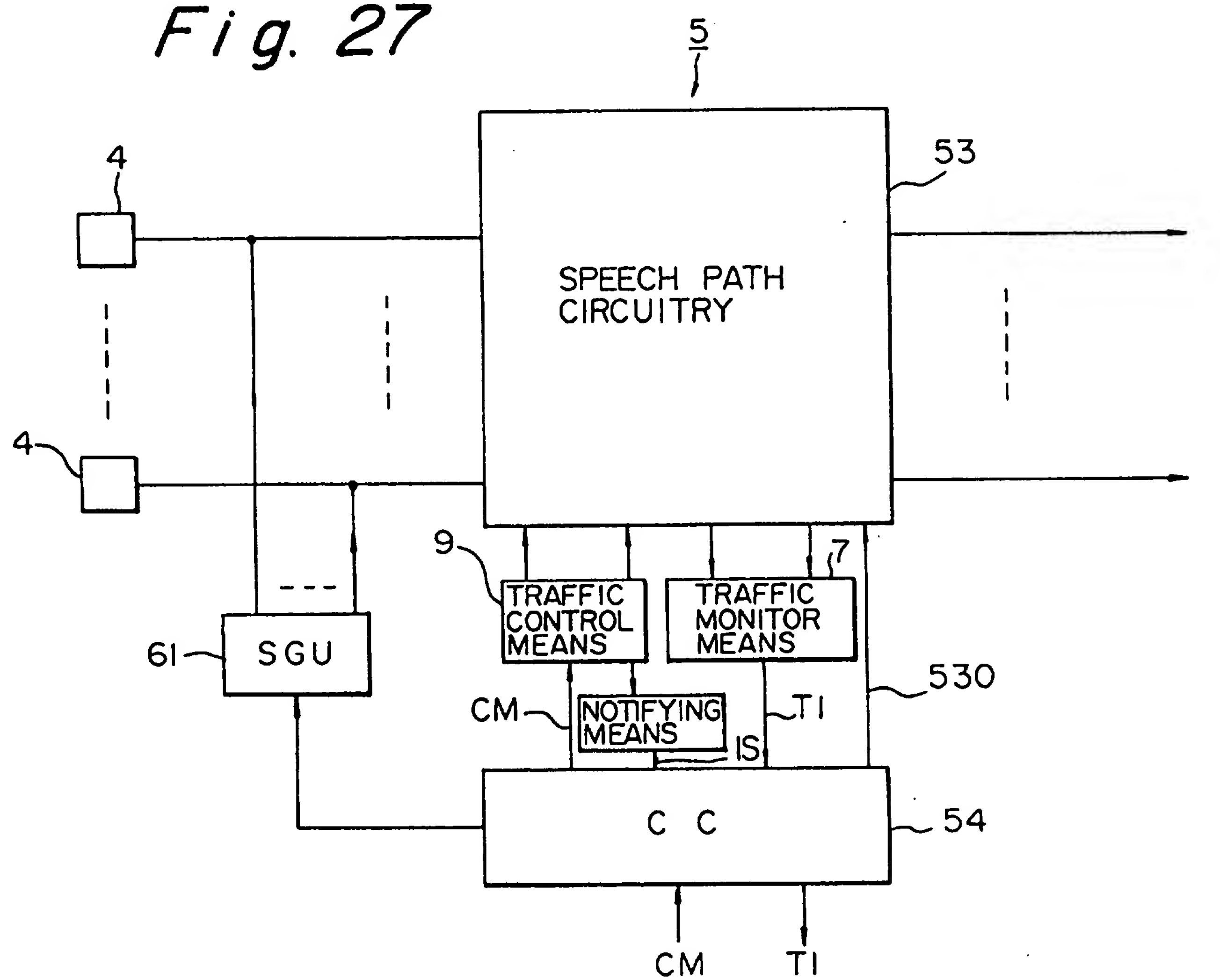
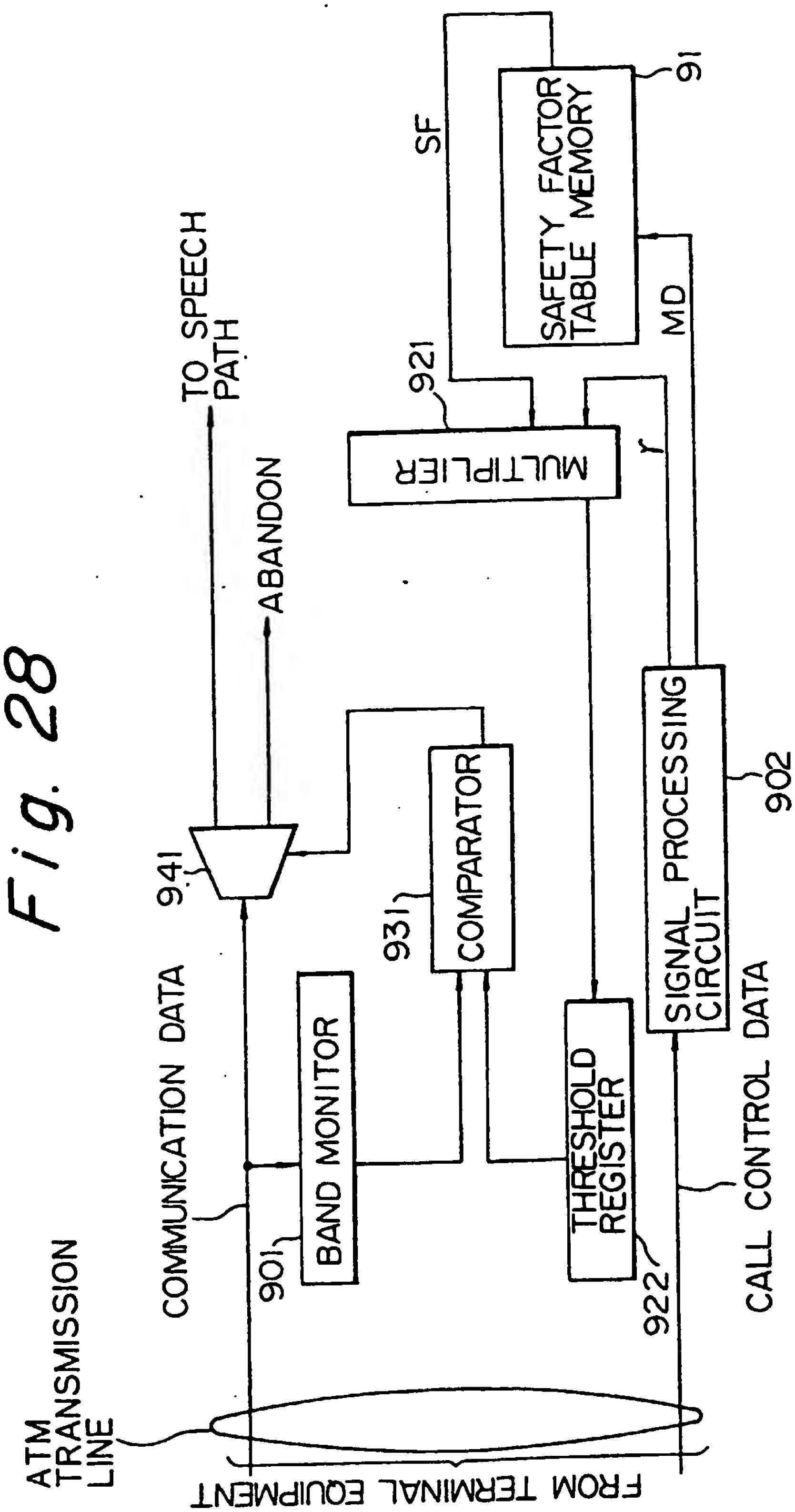

5
53
4
4
SPEECH PATH
CIRCUITRY
9
TRAFFIC
CONTROL
MEANS
7
TRAFFIC
MONITOR
MEANS
61
SGU
CM
NOTIFYING
MEANS
TI
IS
530
C C
54
CM
TI

Fig. 28


TO SPEECH PATH
ABANDON
941
COMMUNICATION DATA
ATM TRANSMISSION LINE
FROM TERMINAL EQUIPMENT
901
BAND MONITOR
931
COMPARATOR
THRESHOLD REGISTER
922
921
MULTIPLIER
SF
SAFETY FACTOR TABLE MEMORY
91
MD
γ
SIGNAL PROCESSING CIRCUIT
902
CALL CONTROL DATA